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LECTURES

ON

COMPARATIVE ANATOMY.

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LECTURES

ON

COMPARATIVE ANATOMY.

TRANSLATED FROM THE FRENCH OF

G. CUVIER,

Member of the National Institute, Professor in the College of France, and in the Central School of the Pantheon, &c.

By WILLIAM ROSS;

UNDER THE INSPECTION OF

JAMES MACARTNEY,

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VOL. I.
ON THE ORGANS OF MOTION.

LONDON,
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FOR T. N. LONGMAN AND O. REES, PATERNOSTER-ROW.

1802.

I3

PREFACE.

The want of any thing like a System of Comparative Anatomy—the extraordinary opportunities, talents and industry of Citizen Cuvier—and the acknowledged importance and utility of the subject, all contribute to render a translation of the present Work highly acceptable to the English Reader.

In conducting the translation which is here offered to the Public, all the care and diligence have been employed which the peculiar nature of the subject required.—

No labour or exertion has been spared by Mr. Ross; and, in revising his manuscript, I have constantly and attentively compared it with the original Work, making such alterations as seemed necessary to render the Author's meaning more plain. The style is, of course, the Translator's own; but I consider myself responsible for the fidelity of the Translation, as far as respects the science.

The names of the Muscles, which are introduced from the new French Nomenclature, have been rendered into Latin, as being most consistent with the general usage of Anatomists, and to avoid the circumlocution they would unavoidably produce in the English language. The same mode has been adopted with respect to many of the terms of Natural History. In every instance, however, where familiar or common language could with propriety be employed, it has been preferred. Considerable difficulty has been experienced in choosing proper English names to correspond with the genera and sub-genera contained in the Tables of Classification; and where these could not be found in popular use, it was judged more expedient to leave blanks, than to create English names, by only altering the termination of the word, which has been the plan pursued in the French Work, where the structure of the language made it more practicable.

I have taken the liberty of correcting some errors in the original, which seemed to have arisen from accidentally substituting one word for another; but in general the strictest regard has been paid both to the Author's mode of description and expression, as making the chief merit in the translation of any work of science.

JAMES MACARTNEY.

LONDON, *March* 18, 1802.

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78— 1	ſimple	ſingle
81—16	*anſeres-birds*	*anſerine* birds
84—17	in	on
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184— 3	between the longiſſimus	between the upper part of the longiſſimus
188—10	*lumbo-ſupra-cadualis*	*Lumbo-ſupra caudales*
217—20	*ſalmorbomboides*	*ſalmo rhomboides*
ibid.—21	*Syngnathus hippocumpus*, or little ſea horſe	*Syngnathus hippocampus*, or *little ſea horſe*
ibid.—23	his ſkin, which ſurrounds his body	its ſkin, which ſurrounds its body
281— 5	muſcles	muſcle
293— 7	(*epitrochlée*) and the external (*epicondyle*)	the *epitrochlea*, and the external, the *epicondyle*
355—20	bone	line
383—20	exterior	extenſor
415— 3	*Tarſo-phalangeus*	*Tibio-phalangeus*

LETTER

FROM

G. CUVIER,

Of the National Institute of France, &c.

TO

JEAN CLAUDE MERTRUD,

Professor of the Anatomy of Animals in the Museum of Natural History, Paris.

The Book I addreſs to you, owes to you its exiſtence; for, whatever intereſt my Lectures may poſſeſs, has ariſen from the uſe which you and your colleagues have permitted me to make of the excellent collection now entruſted to your care—that collection, to the perfection of which you have ſo greatly contributed, and from which Daubenton drew, while he formed it, materials for the moſt important part of an immortal work *.

Enriched

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* Citizen Mertrud held the ſituation of Demonſtrator of Anatomy in the Garden of Plants, from 1750, until that eſtabliſhment was converted into a School of Natural Hiſtory, when

Enriched by the aſſiduous labours of an enlightened adminiſtration, this collection now ſurpaſſes every thing of the kind that exiſts. It preſents, in an arranged and ſyſtematic order, the moſt extenſive development of all the parts of the animal body, prepared in ſpecies the moſt oppoſite—from thoſe which, by their perfection, approach neareſt to man, to thoſe in which we perceive only a pulp ſcarcely organized: thus the ſtudy of Comparative Anatomy is rendered almoſt an amuſement. A ſlight view is ſufficient to enable us to perceive the variations and ſucceſſive gradations of each organ: but the effects which theſe organs produce, remain ſtill unexplained; becauſe there is, in living bodies, ſomething more than thoſe tiſſues and fibres which the eye can trace; becauſe the mechanical part of the organization is, as

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when he was appointed Profeſſor of Comparative Anatomy. He aſſiſted Daubenton in preparing his Anatomical account of moſt of the quadrupeds deſcribed in the Great Natural Hiſtory; and Buffon, who loved and eſteemed him, has complimented his talents in ſeveral of the volumes of that immortal work. His patriotiſm has induced him to refuſe ſome diſtinguiſhed appointments in foreign countries, and, among others, that of firſt ſurgeon to the King of Naples, which was offered to him in 1770, and that of firſt ſurgeon to the King of Spain, to which he was nominated in 1772. He is the inventor of ſeveral ingenious proceſſes relative to making anatomical preparations.

as it were, only the paſſive inſtrument of vitality; and becauſe there occurs, between the firſt impreſſion of the imperceptible elements and the oſtenſible motion which is its laſt effect, an infinite number of intermediate actions, of which no idea has hitherto been formed.

How many combinations and decompoſitions have taken place in this interval! How many affinities have been brought into action!—What Phyſiologiſt is bold enough to hazard conjectures on the greater number of the operations which are performed in the impenetrable laboratory of the animal body? Notwithſtanding the ſucceſsful efforts of our co-temporaries, human Chemiſtry is but in its infancy when compared with that of Nature!

Theſe difficulties, however, ſhould not diſcourage us; and the Anatomiſt muſt make the firſt attempts to overcome them. It is his province to diſcloſe to the Phyſiologiſt the material part of the phænomena and the inſtruments by which the proceſſes are carried on; to deſcribe the canals through which the fluids circulate, and to follow all their ramifications and diſcover all their communications. It belongs to him to meaſure the velocity and determine the direction of each motion.

But to perform this taſk in a ſatisfactory manner, he muſt not be contented merely with a view of what conſtitutes the individual character of the phænomena. It is neceſſary he ſhould in particular diſtinguiſh what forms the general and neceſſary condition of each. To do this he ought to examine all the modifications that may reſult from their various combinations with other phænomena; and alſo, ſeparate or diſengage them from all the neceſſary circumſtances with which they are involved. In ſhort, he muſt not limit himſelf to a ſingle ſpecies of organized beings, but muſt compare the whole; purſuing life, and the phænomena of which it conſiſts, throughout all animated nature. Theſe are the only means by which he can hope to remove the myſterious veil which conceals the eſſence of vitality.

Phyſiology, indeed, is neceſſarily in the ſame ſtate as other phyſical ſciences, which, from the complication and obſcurity of the phænomena, have not hitherto been ſubmitted to calculation. Poſſeſſing no demonſtrated principle, whence the particular facts might be deduced as conſequences, the whole ſcience conſiſts as yet in the ſeries of theſe facts only; and we cannot hope to diſcover general cauſes but in proportion as we may be able to claſs the facts, and ſucceed in arranging them under certain common laws. But phyſiology does not poſſeſs the ſame advantage for attaining this object as thoſe ſciences which are applied to the examination of inorganic ſubſtances; as for example, chemiſtry and experimental philoſophy. The problems to be ſolved by the latter ſciences, may be reduced to a simplicity almoſt indefinite; and the ſubſtances, the nature and relations of which are to be inveſtigated, may be ſeparated from thoſe with which they are connected, and ſucceſſively combined with others. Far narrower are the bounds of phyſiological enquiries: all the parts of a living body are connected: they can perform no functions except when they act in union: to ſeparate one from the maſs, is to reduce it to the rank of inert matter, which is an entire change of eſſence. The machines which are the object of our reſearches, cannot be demonſtrated without being deſtroyed. We have no means of diſcovering what would reſult from the abſence of one or ſeveral of their parts, and conſequently we remain ignorant of the operation of each of theſe parts, in producing the total effect.

Fortunately Nature herſelf ſeems to have prepared for us the means of ſupplying that want which ariſes from the impoſſibility of making certain experiments on living bodies. The different claſſes of animals exhibit almoſt all the poſſible combinations of organs: we find them united, two and two, three and three, and in all proportions; while at the ſame time it may be ſaid that there is no organ of which ſome claſs or ſome genus is not deprived. A careful examination of the effects which reſult from theſe unions and privations is therefore ſufficient to enable us to form probable concluſions reſpecting the nature and the uſe of each organ, or form of organ.

In the ſame manner we may proceed to aſcertain the uſe of the different parts of the ſame organ, and to diſcover thoſe which are eſſential, and ſeparate them from thoſe which are only acceſſary. It is ſufficient to trace the organ through all the claſſes which poſſeſs it, and to examine what parts conſtantly exiſt, and what change is produced in the reſpective functions of that organ, by the abſence of thoſe parts which are wanting in certain claſſes.

But our reſearches muſt not be confined to a few ſpecies. One which is overlooked frequently, contains an exception fatal to a whole ſyſtem; and the method of reaſoning, in phyſiology, juſt pointed out, acquires weight only in proportion as we approach to a perfect knowledge of the anatomy of animals. The latter ſcience therefore cannot, in its preſent ſtate, conduct us directly to certain diſcoveries, though it already forms a touchſtone for the reſults obtained by every other means; and a ſingle fact, in Comparative

Anatomy, often ſuffices to overthrow a complete train of phyſiological hypotheſes.

The importance of Comparative Anatomy has therefore been at all times acknowledged. The abuſe which prevailed towards the end of the 17th century, of ſo often deſcribing the human body from the diſſections of animals, was the cauſe of this branch of ſcience being ſo much neglected during the early part of the preſent century. But the ſtudy has been reſumed with ardour, and a number of eminent men have, for ſome time paſt, made it the object of their peculiar attention.

It is due to the National Muſeum of Natural Hiſtory at Paris, to obſerve, that the learned men connected with that eſtabliſhment, have conſtantly contributed to promote and encourage this ſtudy. The names of *Duverney*, *Ferrein*, and *Petit*, are celebrated in the annals of Science. *Buffon* gave a new attraction to Comparative Anatomy, by diſplaying its importance as the foundation of characters in Natural Hiſtory; and the vaſt labours of his worthy aſſiſtant *Daubenton*, render it henceforth the fixed baſis of Zoology. The latter encouraged, and aided by his advice, as well as by the uſe of the ſubjects entruſted to his care, another of your pupils, who would have carried this ſcience to its height, had not the misfortunes of the times deprived us of his talents in the vigour of life. As an elegant writer, an ingenious phyſiologiſt, and a profound anatomiſt, *Vicq-d'Azyr* never can be replaced; but fortunately thoſe who formed him ſtill exiſt; the treaſures which were confided to him have increaſed; and the ſuperintendants of thoſe treaſures will ſtill find men equally grateful for their uſe, and equally devoted to the promotion of knowledge.

The learned men who compoſe the preſent adminiſtration of the Muſeum, are worthy of imitating the glorious examples of their predeceſſors. I have received from them, as well as from you, all the aſſiſtance I could have expected from an enlightened love for ſcience, rendered more grateful by all the attentions the moſt generous friendſhip could ſuggeſt. Nothing has been ſpared that could lead to diſcoveries, or to the completion of the ſyſtem of our knowledge in Comparative Anatomy. The correſpondents of the Muſeum have imitated the example of its depoſitories. Citizen *Baillon*, in particular, ſo well known by the valuable obſervations which he furniſhed to Buffon, and by thoſe which he continues to make, procured me, with unexampled zeal and generoſity, the rareſt birds and fiſhes. Citizen *Hombert* of Havre, who has applied with the greateſt ſucceſs to the ſtudy of Molluſca and Sea Worms, has favoured me with a great number of theſe animals, the perfect preſervation of which rendered their examination exceedingly uſeful. Citizens *Beauvois*, *Boſc*, and *Olivier*, the two firſt returned from North America, the third from Egypt and Perſia, have kindly communicated to me ſome of the valuable ſpecimens they have brought to Europe. I have therefore no reaſon to envy the good fortune of ARISTOTLE, when a conqueror, who was the friend of the ſciences, made other men ſubſervient to him, and placed millions at his diſpoſal, to enable him to forward the Hiſtory of Nature.

This aſſertion will not ſurprize, when it is known that I have been permitted to diſſect not only the animals which have died in the menagerie, but alſo thoſe which have been brought, during a great number of years, from all parts of the world, and preſerved in ſpirits. Time only was capable of bringing this collection to its preſent degree of perfection, and has, in this inſtance, performed what no other power was capable of accompliſhing.

In opening to me your treaſures—in admitting me to a ſhare of the labours neceſſary to their arrangement and their augmentation, you have impoſed upon me only one condition: that is, to enable other naturaliſts to enjoy them, by giving ſuch a deſcription of them as they merit.

You

You know with what aſſiduity I endeavour to perform this taſk, but you alſo know better than any other what time ſuch a work requires. However rich may be the acquiſitions that are made, more will ſtill be deſired. Sometimes a new ſpecies is diſcovered, which we wiſh to compare with thoſe we already know. Sometimes the conſideration of an organ induces us to make farther attempts to develope its ſtructure. On other occaſions it is neceſſary to extend our obſervations; becauſe ſomething remains to be learned reſpecting the object as a whole or the relation of its parts. In Natural Hiſtory, in particular, we are always diſſatisfied with what we perform, for nature proves to us at each ſtep that ſhe is inexhauſtible. The mechanical part alone, as making preparations, drawings, and engravings, require a time which no care and no expence can abridge.

I cannot therefore reaſonably expect to finiſh my work for ſeveral years. But, in the mean time, I endeavour to diſcloſe to young anatomiſts all that is new and important in the collections: I explain to them the relations which facts already permit us to perceive. I do not merely confine myſelf to an expoſition of the obſervations contained in printed books, but conceal none that I have had the opportunity of making myſelf, in following, though at a diſtance, the footſteps of thoſe celebrated authors who have preceded me. This frankneſs, and the efforts I have made to render the body of the ſcience as complete as the preſent ſtate of our knowledge would permit, having attracted to my claſs ſome pupils diſtinguiſhed for their talents and aſſiduity, they have taken the trouble to collect my lectures in a very accurate manner. Different manuſcripts have been drawn up from theſe notes, which may be conſidered as elementary works, varying in their manner, and I believe more complete in the materials, than any that have hitherto appeared on Comparative Anatomy. Imperfect as theſe manuſcripts muſt in many reſpects be, ſeveral copies have got into circulation, which have been uſefully employed by other Lecturers, and even in ſome printed works. This is a ſlight abuſe, which, though it will not prevent me from continuing to communicate my own obſervations to all who may wiſh to be acquainted with them, is, however, ſufficient to induce me to ſecure to myſelf, by means of the preſs, the property of ſome.

A reaſon of another kind has alſo contributed to determine me to conſent to the publication of one of theſe manuſcripts; and that is, the advantage which the ſtudents attending any courſe muſt derive from poſſeſſing a work that details, in a ſuitable order, the facts of which the profeſſor propoſes to treat, It is almoſt impoſſible that this detail ſhould be accurately given by a public ſpeaker, who is naturally led to expatiate moſt on thoſe ſubjects which are beſt calculated to attract the attention of his auditors; and beſides the rapid ſucceſſion of facts, prevents the ſtudent from fixing on them with ſufficient attention, eſpecially when they are ſo numerous and ſo varied as in Comparative Anatomy. Finally, it appeared to me that this publication might alſo prove both agreeable and uſeful, not only to thoſe anatomiſts who have it not in their power to hear my lectures, but to all perſons who apply themſelves to the ſtudy of Phyſiology and Natural Hiſtory, who have hitherto poſſeſſed no book in the form of a complete ſyſtem on the internal organization of animals. Though the preſent ought not, and indeed cannot be conſidered in any other light than as a kind of abridgement or program of the great work in which I am engaged; it is not the leſs true, that it already contains a vaſt collection of facts, and that it may ſerve as the baſis of more extenſive reſearches. Perhaps it may prove an inducement, to perſons intereſted in its object, to publiſh the new or ſeparate facts that occur to them, and which may occupy a place in my great work.—Perhaps important views and corrections may be pointed out to me. In a word, I ſhall not regret that I have ſubmitted an imperfect work to the eye of criticiſm, if it may be hereafter the means of procuring, either through myſelf or others, ſome advantage to Science.

Theſe Lectures were drawn up from my oral demonſtrations by Citizen Dumeril, one of my deareſt pupils and beſt friends, and whoſe talents have been lately rewarded by a public appointment to the important place of Chief of the Anatomical Labours of the School of Medicine. Having attended my courſe during four years, he has collected all my obſervations with ſo much accuracy, that it would have been difficult for me to have performed the taſk better. I have reviſed his manuſcript with the greateſt care. I have every where ſupplied details which could not be conveniently introduced in public lectures. I have rectified ſuch ſtatements as I had advanced too raſhly. I have added every information connected with theſe lectures that I have obtained ſince their delivery by my diſſections and reading. I therefore do not heſitate to acknowledge this work as my own, and to avow all the aſſertions it contains.

It is not, however, with his pen only that Citizen Dumeril has contributed to this work. He always aſſiſted me in the numerous diſſections I found it neceſſary to make. He conducted ſeveral of theſe diſſections, according to views peculiar to himſelf, and ſuggeſted by his extenſive knowledge in natural hiſtory and phyſiology. I am indebted to his perſpicuity for a number of intereſting obſervations and curious facts, which would have eſcaped me.

I am alſo much indebted to the complaiſance of Citizen Rouſſeau, your aſſiſtant anatomiſt in the Muſeum of Natural Hiſtory. Equally modeſt and indefatigable, he merits the thanks of all anatomiſts for the laborious duty he performs under your direction, in preſerving and augmenting the anatomical collection. Without his aſſiſtance it would have been impoſſible for me to have rendered my lectures worthy of publication.

The neceſſity of ſuch aſſiſtance will be eaſily conceived, when it is conſidered how many diſſections are required in preparing a work of this kind, and how ſeldom opportunities occur for diſſecting certain ſpecies. He who deſcribes only the human body, may proceed at his leiſure in the examination of a ſubject, of which only ſome minute parts remain to be diſcovered, and which he may always replace whenever he wiſhes to verify or correct his obſervations. But he who ſtudies the ſtructure of other animals, when he has a new ſubject to diſſect, is obliged to deſcribe every part; and if the ſpecies be alſo ſcarce, or that he has no hope of ſeeing it again, and cannot expect to be able to rectify his obſervations, he is under the neceſſity of making his reſearches as accurate as extenſive. He muſt therefore paſs his days and his nights in purſuits no leſs unhealthful than laborious.

It would indeed be impoſſible for one man to undergo the fatigue of even the purely mechanical part of the ſtudies neceſſary in forming a ſyſtem of Comparative Anatomy, were he not ſeconded by friends as zealous as himſelf for the progreſs of knowledge.

The reader will eaſily perceive that this aſſiſtance muſt have been extremely uſeful to me, as my Lectures are all founded on obſervation, and as, except a few facts, the authorities for which I have carefully cited, I have advanced nothing which is not conſiſtent with my own knowledge. On this account I have thought numerous references unneceſſary in this publication, though I ſhall not neglect them in my greater work; becauſe I conſider theſe quotations as a tribute of reſpect paid to the memory of the firſt diſcoverers of uſeful facts. In omitting the names of authors, therefore, I do not pretend to any priority of obſervation, but I would have it underſtood that the ſtatements I make may be conſidered as additional authorities to thoſe which already exiſt, reſpecting the ſame facts.

I muſt alſo obſerve, that this omiſſion of citations as to the facts I have had the opportunity of proving myſelf, and which I have frequently demonſtrated publicly in my claſs, or the proofs of which are depoſited in the Anatomical Collection of the Muſeum, aroſe from the conſideration, that theſe public demonſtrations and expoſitions rendered all other authorities unneceſſary, and not from my negligence in inquiring what others had performed before me. I believe I have not remained far behind my predeceſſors: in many caſes I have found it more eaſy to reſort to Nature, than to endeavour to explain the obſcure and unſatisfactory deſcriptions of ſome moderns, or to ſpend my time in bringing to light a few valuable obſervations, which lie buried amidſt the diſcuſſions of ſcholaſtic philoſophy, which fill the pages of the authors of the ſixteenth century: but this method, which relieves me from the neceſſity of having recourſe to compilation, I regard as an advantage, procured to me by my fortunate ſituation, and by no means as a ground of cenſure.

I have, beſides, been more particularly diſſuaded from uſing foreign materials, by obſerving the imperfect works which ſome eſtimable authors, who wanted the means of obſervation, have produced by that mode of compilation: it was impoſſible they ſhould avoid making falſe ſtatements, ſince they had to rely upon incorrect, and even contradictory authorities; and as the conſtant view of Nature did not reſtrain the flights of their imaginations, they could not reſiſt the temptation of forming ſyſtems, nor ſecure their judgments from a partiality that induced them to ſelect, in preference, thoſe facts which were moſt favourable to their own ideas.

You will eaſily conceive, that the greater number of theſe authors are found among a people, who, though celebrated for their inventive genius, and indefatigable patience in every kind of reſearch, have not always been able to confine, within due bounds, their deſire to diſplay erudition—a deſire which perhaps proceeds from too much modeſty, and a miſtaken deference for others.

Another people, no leſs admirable for their bold views, and vigorous proſecution of the ſciences, ſeem to have fallen into the oppoſite exceſs of that which I have juſt blamed, by contemning the labours of foreigners, and eſteeming, and even conſulting, almoſt excluſively, the works of their own countrymen. This kind of pride, which is perhaps uſeful in politics, when carried into the ſciences, and above all in the ſciences which depend on facts, tends only to produce contracted ideas, and leads to a barrenneſs which forms the character of ſome of their authors in Natural Hiſtory and Comparative Anatomy.

I hope you will find that I have done every thing in my power to avoid theſe two errors; and that, though reſolved always to examine nature myſelf, I have not attempted to proceed without guides, but have followed thoſe who were capable of leading me in new or uſeful paths.

I believe I have made uſe of the principal diſcoveries of the modern authors, who have treated Anatomy in a phyſiological manner. Stenon, Swammerdam, Collins, Duverney, Petit, Lyonnet, Haller, Monro, Hunter, Geoffroy, Vicq-d'Azyr, Camper, Blumenbach, Scarpa, Comparetti, Kielmeyer, Poli, Harwood, Barthez, have furniſhed the data with which I commenced my career; and though I have myſelf reviewed a conſiderable part of theſe data, the glory of diſcovering them is not the leſs due to the celebrated men I have mentioned; and, had it not been for their writings, the greater number of facts recorded in this work would have eſcaped my notice.

I ought alſo to acknowledge the advantages I have derived from the moſt modern naturaliſts. Since Nature is at laſt adopted as the baſis of all arrangement in Natural Hiſtory, the relations of that ſcience with Anatomy are become more intimate; the one cannot advance a ſtep, which will not tend to the advantage of the other; the connections which the firſt eſtabliſhes, frequently indicate reſearches, which the other ought to make: thus, without mentioning Daubenton and Pallas, equally placed in the firſt rank in either ſcience, I am much indebted for views, and, above all, for the regularity of my plan, to the modern zoologiſts, among whom I ought, in particular, to name Ray, Klein, Linnæus, Buffon, Lacépéde, Lamarck, Bloch, Fabricius, Latreille, and all thoſe who have, by different ways, attempted to approach that ſimple natural method of claſſification, which ought to be the object of all the efforts of naturaliſts, though it may perhaps be the philoſopher's ſtone of their art.

As ſome of theſe celebrated men honour me with their friendſhip, I have profited no leſs by their converſation than by their writings. Several of my ideas have originated in theirs, which I have ſo generally adopted, that it is with difficulty I can recognize what I owe to each of them.

I have endeavoured to approach nearer to a natural arrangement in the tables connected with this work, than I did in my Elements of Zoology. I have made ſeveral changes in the diſtribution of the animals, which appear to me very advantageous; and I alſo owe a part of theſe improvements to the reſearches of the learned men I have juſt named. It will be eaſily diſcovered that I have profited by the works of Citizen Lacépéde on Birds and Mammalia, by that of Citizen Lamarck on the Teſtacea, and that the diviſion of Reptiles is the ſame which has been lately propoſed by Citizen Brongniard.

In this avowal, you will doubtleſs recognize the deſire of rendering a laſting teſtimony of the gratitude I owe to all whoſe ideas and labours have proved uſeful to me in the execution of this work; but I have alſo another object, which, perhaps, may eſcape your obſervation: it is my wiſh to promote and maintain that amiable and meritorious ſpirit of communication, which now prevails among the greater number of Naturaliſts. Employed in cultivating together the vaſt field of Nature, they may be ſaid to live in a community of labour and advantage: if one, therefore, diſcover a fact, it is of little importance whoſe name is attached to it.

I beſides rely on the judgment of perſons ſkilled in Anatomy, to diſtinguiſh the obſervations which are peculiar to myſelf; and I hope they will find them ſufficiently numerous to juſtify my conſent to the premature publication of theſe Lectures. I may be permitted to expreſs this hope with the greater freedom, as I pretend to no other merit in preparing them, than that of having profited by a very favourable ſituation.

In the part which relates to Human Anatomy, I have not attempted to make any new obſervations: on that branch of the ſubject I have juſt ſaid what appeared neceſſary to recal the idea of the parts to the Reader; and though my deſcriptions have actually been taken from the dead ſubject, ſome details in Neurology excepted, for which I have followed Sabattier and Sœmmering, they differ from thoſe of my predeceſſors only in the expreſſion.

Citizen *Dumeril* has almoſt every where inſerted his new nomenclature, which is analogous to that propoſed by Citizen *Chauſſier*, and which Citizens *Dumas* and *Girard* have each modified according to their manner. Without attaching much importance to this improvement, I may obſerve, that it would be uſeful, were Anatomiſts to agree in fixing the language of their art.

Phyſiology occupies only an acceſſary place in theſe Lectures. I have only occaſionally introduced it, to diminiſh a little the unavoidable tedioufneſs of anatomical deſcriptions, and to point out different views, which Comparative Anatomy may furniſh to the phyſiologiſt.

For the ſame purpoſe I have ſometimes ſtated facts, which belong more particularly to what is ſtrictly called Natural Hiſtory. It was found frequently neceſſary to remind the Reader of ſome fact, calculated to ſupport the anatomical theories, or to indicate ſome corrections, which the obſervations of Comparative Anatomy render neceſſary in methodical claſſifications.

Such are the motives which have induced me to publiſh theſe Lectures. I have now only to expreſs my hope, that Naturaliſts will not accuſe me of having taken this ſtep too haſtily, and that the utility they may find in the work will appear to them ſufficient to excuſe its preſent imperfections.

Grant me then that indulgence, which, if not due to the importance of this Work, is at leaſt merited by the ſincere and reſpectful ſentiments with which it is preſented to you, by your Diſciple and Friend.

G. CUVIER.

Garden of Plants,
28th of Ventoſe, and Year 8 (1800.)

LECTURES

ON

COMPARATIVE ANATOMY.

LECTURE FIRST.

PRELIMINARY OBSERVATIONS UPON THE ANIMAL ŒCONOMY.

ARTICLE I.

General View of the Functions of Animal Bodies.

THE idea of *Life* is one of thoſe general and obſcure ideas produced in us by obſerving a certain series of phænomena poſſeſſing mutual relations, and ſucceeding each other in a conſtant order. We know not indeed the nature of the link that unites theſe phænomena, but we are ſenſible that a connexion muſt exiſt; and this conviction is ſufficient to induce us to give it a name, which the vulgar are apt to regard as the ſign of a particular principle, though in fact that name can only indicate the totality of the phænomena which have occaſioned its formation.

Thus, as the human body, and the bodies of ſeveral other animals reſembling it, appear to reſiſt, during a certain time, the laws which govern inanimate bodies, and even to act on all around them in a manner entirely contrary to thoſe laws, we employ the terms *life* and *vital force* to deſignate what are at leaſt apparent exceptions to general laws. It is, therefore, by determining exactly in what the exceptions conſiſt, that we ſhall fix the meaning of thoſe terms. For this purpoſe, let us conſider the bodies I have mentioned, in their active and paſſive relations with the reſt of nature.

For example, let us contemplate a female in the prime of youth and health. That elegant voluptuous form—that graceful flexibility of motion—that gentle warmth—thoſe cheeks crimſoned with the roſes of delight—thoſe brilliant eyes, darting rays of love, or ſparkling with the fire of genius—that countenance, enlivened by ſallies of wit, or animated by the glow of paſſion, ſeem all united to form a moſt faſcinating being. A moment is ſufficient to deſtroy this illuſion. Motion and ſenſe often ceaſe without any apparent cauſe. The body loſes its heat; the muſcles become flat, and the angular prominences of the bones appear; the luſtre of the eye is gone; the cheeks and lips are livid. Theſe, however, are but preludes of changes ſtill more horrible. The fleſh becomes ſucceſſively blue, green, and black. It attracts humidity, and while one portion evaporates in infectious emanations, another diſſolves into a putrid ſanies, which is alſo ſpeedily diſſipated. In a word, after a few ſhort days there remains only a ſmall number of earthy and ſaline principles. The other elements are diſperſed in air, and in water, to enter again into new combinations.

It is evident that this ſeparation is the natural effect of the action of the air, humidity and heat—in a word, of external matter upon the dead body; and that it has its cauſe in the elective attraction of thoſe different agents for the elements of which the body is compoſed. That body, however, was equally ſurrounded by thoſe agents while living, their affinities with its molecules were the ſame, and the latter would have yielded in the ſame manner during life, had not their coheſion been preſerved by a power ſuperior to that of thoſe affinities, and which never ceaſed to act until the moment of death.

Of all the phænomena, the particular ideas of which enter into the general idea of life, this is what at firſt ſight appears to conſtitute its eſſence, ſince we can form no conception of life without it, and ſince it evidently exiſts without interruption until the inſtant of diſſolution.

But a further ſtudy of any living body convinces us, that the power which preſerves the union of the moleculæ, notwithſtanding the external forces which tend to ſeparate them, does not confine its activity to this tranquil operation, and that the ſphere of its action extends beyond the bounds of the living body itſelf. At leaſt it does not appear that this power differs from that which attracts new moleculæ to depoſit them between thoſe that already exiſt: and this action of the living body, in attracting the ſurrounding moleculæ, is not leſs conſtant than that which it exerciſes in retaining its own; for, beſides that the abſorption of the alimentary matter, its converſion into nutritive fluid, and its ſubſequent tranſmiſſion to all the parts of the body, experiences no interruption, and continues from one repaſt to the other; another abſorption conſtantly takes place at the external ſurface, and a third by the effect of reſpiration. The two latter are thoſe only which exiſt in all living bodies which do not digeſt, that is to ſay, in all plants.

Living bodies however do not increaſe indefinitely. Nature has aſſigned to each limits which it cannot exceed. It follows, therefore, that they muſt loſe, in one way, a great part of what they gain in another; and indeed an attentive obſervation has convinced us, that tranſpiration, and a number of other cauſes, tend continually to diminiſh their ſubſtance.

This conſideration muſt modify the idea which we at firſt formed from the principal phænomenon of life. Inſtead of a conſtant union in the moleculæ, we cannot avoid obſerving, that there is a continual circulation from the exterior to the interior, and from the interior to the exterior of bodies—a circulation which, though uniformly preſerved, is notwithſtanding fixed within certain limits. Thus living bodies may be conſidered as a kind of furnaces, into which inert ſubſtances are ſucceſſively thrown, which combine among themſelves in various manners, maintain a certain place, and perform an action determined by the nature of the combinations they have formed, and at laſt fly off in order to become again ſubject to the laws of inanimate nature.

It muſt be obſerved, however, that there is a difference, depending on age and health, in the proportion of the parts which enter into this torrent, and thoſe which abandon it; and that the velocity of the motion uſually varies according to the different conditions of each living body.

It appears, at the ſame time, that life is terminated by cauſes ſimilar to thoſe which interrupt all other known motions; and that the hardening of the fibres, and the obſtruction of the veſſels, render death the neceſſary conſequence of life, as repoſe is of motion, even though the criſis were not accelerated by innumerable cauſes which are foreign to the living body.

This general and common motion of all the parts forms ſo peculiarly the eſſence of life, that the parts which are ſeparated from a living body ſoon die, becauſe they poſſeſs no motion of their own, and only participate in the general motion produced by their union. Thus, according to the expreſſion of Kant, the mode of exiſtence of each part of inanimate bodies belongs to itſelf, but in living bodies it reſides in the whole.

The nature of life, as above deſcribed, being once well aſcertained by the obſervation of the moſt conſtant of its effects, it would naturally be wiſhed to inveſtigate its origin, and to inquire how it is communicated to the bodies it animates. Living bodies have therefore been traced to their infancy; and it has been endeavoured to carry this examination as near as poſſible to the moment of their formation. But they have never been obſerved otherwiſe than completely formed, and already enjoying that vital force, and producing that vortex-like motion, the firſt cauſe of which we are deſirous of knowing. In fact, however feeble and minute the parts of an embryo, or of the ſeed of a plant, may be at the moment we are firſt capable of perceiving them, they then enjoy a real life, and poſſeſs the germ of all the phænomena which that life may afterwards develope. Theſe obſervations, extended to all the claſſes of living bodies, lead to this general fact, that there are none of thoſe bodies which have not heretofore formed part of a body ſimilar to itſelf, from which it has been detached. All have participated in the exiſtence of other living bodies, before

fore they exerciſed the functions of life by themſelves; and it was even by means of the vital force of the bodies to which they formerly belonged, that they were enabled to develope themſelves ſo completely as to become capable of enjoying ſeparate vitality; for, though the particular action of copulation is neceſſary for the production of a number of ſpecies, many are produced without it; copulation, therefore, is only a circumſtance peculiar in certain caſes, and does not change the eſſential nature of generation. It appears then that the motion proper to living bodies has really its origin in that of their parents. It is from them they have received the vital impulſe; and hence it is evident, that, in the actual ſtate of things, life proceeds only from life, and that there exiſts no other except that which has been tranſmitted from one living body to another by an uninterrupted ſucceſſion.

Unable to aſcend to the origin of living bodies, there remains then within our reach no ſource of information reſpecting the real nature of the powers which animate them, except the examination of the compoſition of thoſe bodies, that is to ſay, of their texture, and the compoſition of their elements: for, though it may be truly ſaid, that this texture, and this compoſition, are in ſome manner the reſult of the action of the vital impulſe which has given them being, and which maintains them; it is alſo evident, that in them only this impulſe can have its ſource and foundation: and if the firſt union of the chemical and mechanical elements of any living body has been effected by the vital force of the body from which it deſcended, we ought to find in it a ſimilar power, and alſo the cauſes of that power, ſince it has to exerciſe a like action in favour of the bodies which are to deſcend from it.

But this compoſition of living bodies is too imperfectly known to enable us to deduce clearly from it the effects they exhibit. We obſerve, in general, that they are compoſed of fibres or laminæ, forming altogether a ſeries of reticulated ſubſtances more or leſs compact, which form the baſes of all their ſolids, as well of thoſe that are maſſy, as of thoſe that preſent the appearance of laminæ and filaments. We are acquainted with the form, the conſiſtence, and the poſition of the larger of thoſe ſolids; the ramifications of the moſt conſiderable of their veſſels, and the courſe of the fluids they contain: but their more minute branches, and their more ſecret texture, cannot be traced by our inſtruments. We likewiſe know the chemical characters of the moſt apparent of the different fluids and concrete ſubſtances: we can even decompoſe them to a certain point. This analyſis, however, is not only imperfect, ſince we cannot recompoſe them, but the phænomena indicate, that there muſt exiſt ſeveral other fluids which it has hitherto been impoſſible for us to diſcover.

The efforts hitherto made by naturaliſts to prove a connexion between the phænomena of living bodies and the general laws of nature, have doubtleſs been unſucceſsful. It would, however, be wrong, on that account, to conclude that thoſe phænomena are abſolutely of a different kind; but, on the other hand, there would be much temerity in reſuming this taſk, while our knowledge of the bodies in which the phænomena appear is ſo limited. We ſhould be able to give only an empirical expoſition, inſtead of a rational ſyſtem. All our labours on organic œconomy muſt therefore be confined to its hiſtory.

If, however, our knowledge of the compoſition of living bodies be not ſufficient for the explanation of the phænomena they exhibit, we may at leaſt employ it in recognizing thoſe bodies when out of a ſtate of action, and in diſtinguiſhing their remains long after death; for we find in no inert body that fibrous or cellular texture, nor that multiplicity of volatile elements which form the characters of organization and organized bodies, whether in thoſe that are alive, or in thoſe that have lived.

We know that inert ſolids are compoſed only of polyædrous moleculæ, which attract each other by their ſides, and never move except to ſeparate—that they reſolve into a very ſmall number of elementary ſubſtances with reſpect to our inſtruments—that they are formed of the combination of thoſe ſubſtances, and the accumulation of thoſe molecules—that they grow only by the juxta-poſition of new molecules, the ſtrata of which envelope the preceding maſs—and that they are deſtroyed only by ſome mechanical agent ſeparating their parts, or ſome chemical agent altering their combinations; but organized bodies, which are tiſſues of fibres and laminæ, and have their interſtices filled with fluids, reſolve almoſt entirely into volatile ſubſtances, are produced by bodies ſimilar to themſelves, from which they do not ſeparate until they are ſufficiently developed to act by their own force; conſtantly aſſimilate foreign ſubſtances, and depoſit them between their particles; grow by an internal power, and finally periſh by that internal principle, or by the effect of life itſelf.

Origin by *generation*, growth by *nutrition*, termination by *death*, are the general and common characteriſtics of all organized bodies: If, however, there are bodies which perform only theſe functions, and thoſe which are ſubſidiary to them, and poſſeſs only the organs neceſſary for ſuch operations, there are a great number of others which perform particular functions, that not only require appropriate organs, but neceſſarily modify the manner in which the general functions are performed, and the organs proper to thoſe functions.

Among the leſs general faculties which indicate organization, but which are not the neceſſary conſequences of it, the faculty of ſenſation, and that of voluntary motion, in whole or in part, are the moſt remarkable, and thoſe which have the greateſt influence on the other functions.

We are conſcious that theſe faculties exiſt in ourſelves, and we attribute them, by analogy, and from their apparent exiſtence, to a number of other beings, whom we therefore name *animated* beings, or, uſing a ſingle word, *animals*.

It appears that theſe two faculties are neceſſarily connected, the idea of *ſenſation* is even included in that of *voluntary motion*; for we cannot conceive volition without deſire, and unaccompanied by the ſentiment of pleaſure or pain. There may indeed exiſt inanimate bodies, that manifeſt external motion produced by an internal principle; but their movements are not of the ſame nature as thoſe which conſtitute the functions eſſential to life, and do not merit the name of voluntary.

On the other hand, the bounty which nature diſplays in all her productions, does not permit us to believe that ſhe has deprived beings ſuſceptible of ſenſation; that is to ſay, of pleaſure and pain—of the power, in a certain degree, of avoiding the one and purſuing the other.—Among the misfortunes which afflict our ſpecies, one of the moſt painful is the ſituation of a man of courage withheld by a ſuperior power from reſiſting oppreſſion; and the poetic fictions beſt calculated to excite compaſſion, are thoſe which repreſent ſentient beings incloſed within immoveable bodies. The ſighs of Clorinda iſſuing, with her blood, from the trunk of a cypreſs, would arreſt the fury of the moſt ſavage of mortals *.

But, independently of the chain which connects the two faculties, and the double ſyſtem of organs they require, they are accompanied by ſeveral modifications in thoſe faculties which are common to all organized bodies: theſe modifications, joined to the two firſt mentioned faculties, are what more particularly conſtitute the nature of animals.

With reſpect to nutrition, for example, vegetables, which are attached to the ſoil, abſorb immediately, by their roots, all the nutritive parts

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* In this elegant illuſtration, Citizen Cuvier has made a very happy uſe of the fable of Taſſo:

' Pur tragge al fin la ſpada, e con gran forza
' Percote l'alta pianta; O meraviglia;
' Manda fuor ſangue la reciſa ſcorza,
' E fa la terra intorno a ſe vermiglia:
' Tuto ſi raccapriccia, et pur rinforza
' Il colpo, e'l fin vederne ei ſi conſiglia.
' Allhor, quaſi di tomba, uſcir ne ſente,
' Un' indiſtinto gemito dolente. &c.'

See *La Gieruſalemme Liberata*——*Canto* XIII.

TRANSLATOR.

parts of the fluids which they imbibe. Theſe roots are ſubdivided to extreme minuteneſs; they penetrate into the ſmalleſt interſtices, and proceed, if it may be ſo ſaid, to ſeek at a diſtance food for the plant to which they belong. Their action is tranquil and uniform, and never is interrupted except when deprived by drought of the juices which they require.

Animals, on the contrary, which are not fixed, and which frequently change their place, can tranſport with themſelves a portion of the ſubſtances neceſſary for their nutrition: they have therefore received an internal cavity, into which they depoſit the matters deſtined for their aliment; and the inward ſurfaces of this cavity are furniſhed with innumerable abſorbing pores or veſſels, which, according to the energetic expreſſion of Boerhaave, are real *internal roots:* the magnitude of this cavity, in a number of animals, permits them to introduce ſolid ſubſtances into it. It was neceſſary, then, that they ſhould have inſtruments for dividing thoſe ſubſtances, and liquors for diſſolving them. In a word, with ſuch animals nutrition does not immediately commence upon the abſorption of the ſubſtances which the ſoil or the atmoſphere furniſh them. It is neceſſarily preceded with a vaſt number of preparatory operations, the whole of which conſtitute *digeſtion.*

Thus, it appears, that digeſtion is a function of a ſecondary order, proper to animals, the exiſtence of which, as well as of the alimentary canal in which it is performed, is rendered neceſſary by the faculty they poſſeſs of voluntary motion; but this is not the only conſequence of that faculty.

The faculties of vegetables being very few, their organization is very ſimple; almoſt all their parts are compoſed of fibres, which are either parallel, or diverge very little. Farther, their fixed poſition admits, that the general motion of their nutritive fluid may be preſerved by ſimple external agents. It appears that it proceeds upwards, by the effect of the ſuction of their ſpongy or capillary texture, and the evaporation which takes place at their top, and that its motion in that direction is the more rapid in proportion as the evaporation is great. It appears alſo that the motion of this fluid may even become retrograde, when it ceaſes to flow in its uſual courſe, or changes into abſorption by the coolneſs and humidity of the air.

It is not only neceſſary that animals deſtined continually to change their place of exiſtence, and to live in all kinds of ſituations and temperatures, ſhould poſſeſs within themſelves an active principle of motion for their nutritive fluid; but, their more numerous and more developed faculties requiring a much greater complication of organs, their various parts being differently formed, often at a diſtance from each other, and even capable of changing their reſpective poſitions and directions, means more powerful, and otherwiſe diſpoſed than in vegetables, are neceſſary for tranſmitting this fluid through ſuch a multiplicity of intricate windings.

In the greater part of animals, therefore, this fluid is contained in innumerable canals, which are the ramifications of two trunks communicating with each other, in ſuch a manner that the one receives in its roots the fluid which the other has puſhed into its branches, and carries it back to the centre, to be again driven forward from that point.

Where the two great trunks communicate, the heart is placed: it is merely an organ, the contractions of which drive this fluid forward with great force into all the ramifications of the arterial trunk. It has two orifices, the valves of which are ſo diſpoſed that the fluid contained in the whole vaſcular ſyſtem can proceed in no other manner than in that we have pointed out; that is to ſay, from the heart towards the other parts of the body by the *arteries*, and from thoſe parts back to the heart by the *veins*.

In this movement, by rotation, conſiſts the circulation of the blood, which is another function, of a ſecondary order, proper to animals, and of which the heart is the principal agent and the regulator; but this function is not ſo neceſſarily connected with the faculties of ſenſation and motion as the function of digeſtion is; for two numerous claſſes of animals are completely deprived of circulation, and are nouriſhed like vegetables, by ſimply imbibing a fluid which is prepared in the inteſtinal canal.

In the animals that have a circulation, the blood appears to be merely a vehicle which is continually receiving from the alimentary canal, from the external ſurface of the body, and from the lungs, different ſubſtances, which are intimately incorporated with it, and with which it replaces thoſe it furniſhes to all the different parts of the body for their preſervation and growth. It is on its paſſage to the extremities of the arteries that the blood effects the real nutrition of the parts; and alſo changes, in its paſſage, its nature and its colour: and it is only by the acceſſion of the different ſubſtances which I proceed to point out, that the veinous blood is rendered proper for nutrition, or, in one word, becomes *arterial* blood.

It is by particular veſſels, called *lymphatics*, that the veinous blood receives the ſubſtances with which the ſkin and the alimentary canal ſupply it. By them, alſo, it receives even the reſiduum of nutrition, and the particles which are detached from different parts, to be carried out of the body by various excretions.

With reſpect to the lungs, the air that penetrates into them produces, with the veinous blood, a kind of combuſtion, which appears to be neceſſary to the exiſtence of all organized bodies:

bodies; for it takes place in them all, though in very different ways.

Vegetables, and animals which have no circulation, *reſpire* throughout the whole of their ſurface, or by veſſels which introduce the air at different points into the interior of their bodies. No animals reſpire by a particular organ, except thoſe that have a real circulation, becauſe, in them, the blood coming from one common ſource, the heart, to which it conſtantly returns, the veſſels that contain it are ſo diſpoſed that it cannot arrive at the other parts until it has paſſed through the lungs. This, however, cannot take place in vegetables, or in thoſe animals in which this fluid is every-where diffuſed in an uniform manner, without being contained in veſſels.

Hence it appears that pulmonary or branchial reſpiration is a function of a third order, the exiſtence of which depends on that of circulation, and which is one degree removed from thoſe faculties that characterize animals.

It is not ſo with generation, as the manner in which this act is performed by animals does not depend on their particular faculties, at leaſt with regard to the fecundation of the ova; for the faculties they poſſeſs of moving and advancing towards each other, of deſiring and enjoying, has fitted them for taſting all the delights of love: with reſpect to the purely mechanical part, their ſpermatic fluid has no occaſion for any envelope, and is capable of being tranſmitted directly to the ova; but in vegetables, which do not poſſeſs within themſelves the power of directing this fluid, it was neceſſary that it ſhould be encloſed in little capſules, which are ſuſceptible of being tranſported by the winds, and which form what is called the *pollen* of the *ſtamina:* thus, while animals, for the performance of moſt of their other functions, have, in conſequence of faculties peculiar to themſelves, received more complicated organs, they are enabled, by thoſe characteriſtic faculties, to exerciſe the functions of generation in a manner more ſimple than vegetables.

Theſe examples ſhew how much influence the faculties of ſenſation and motion, which animals poſſeſs in addition to thoſe of vegetables, have over the organs of all the other faculties which are common to both theſe kind of beings. The compariſon which we ſhall hereafter make of the different orders of animals, will, in the ſame manner, demonſtrate that the modifications of their principal functions exerciſe a ſimilar influence on all the others:—Such is the union and harmony which prevails in all the parts of living bodies.

We have thus deſcribed the principal functions which compoſe the animal œconomy. It is obvious that they may be divided into three diſtinct orders. There are ſome which, in conſtituting animals what they are, fit them for fulfilling

filling the part that nature has aſſigned to them in the general arrangement of the univerſe—in a word, which would be ſufficient for their exiſtence, if that exiſtence were only momentary. Theſe are the faculties of ſenſation and motion: The latter enables them to execute certain actions, and the former determines their choice of the particular actions they are capable of performing. Each animal may be conſidered as a partial machine, co-operating with all the other machines, the whole of which form the univerſe: the organs of motion are the wheels and levers, in ſhort, all the paſſive parts; but the active principle, the ſpring which gives the impulſe to every part, reſides only in the ſenſitive faculty, without which the animal, plunged in a continual ſlumber, would be reduced to a ſtate purely vegetative;—plants themſelves, as Buffon has obſerved, may be called animals which ſleep. Theſe two functions form the firſt order, and are termed *animal functions*. But animal machines, unlike thoſe we conſtruct, poſſeſs an internal principle of preſervation and reparation. This principle conſiſts in the union of the different functions which ſerve to nouriſh the body, that is to ſay, *digeſtion*, *abſorption*, *circulation*, *reſpiration*, *tranſpiration*, and the *excretions*. Theſe form the ſecond order, and are denominated *vital functions*.

Finally, the duration of each animal's life being determined according to its kind, *generation*

tion is a function of a third order, by which the individuals that periſh are replaced by others, and the exiſtence of each ſpecies maintained.

Having conſidered theſe functions with reſpect to themſelves, and to their reciprocal relations, we ſhall next examine the organs by which they are performed.

Article II.

General Idea of the Organs of which the Animal Body is compoſed.

No part of the animal body is compoſed entirely of ſolid particles; they all yield fluids by expreſſion, or loſe them by exſiccation; and they all exhibit the appearance of an areolated or reticular texture.

The mechanical diviſion of the ſolids conducts us, in the laſt reſult, to lamellæ, or filaments, which ſeem to be the elementary moleculæ. When the lamellæ are ſeparate, and intercepted by ſenſible vacancies, they form what is called cellulofity. This cellulofity not only envelopes and pervades the moſt denſe parts, but it appears to form almoſt always their baſis; for membranes conſiſt only of a more compact cellulofity, the lamellæ of which are more cloſely approximated, and placed more exactly above each other, and are reſolved into an ordinary cellulofity by maceration. The veſſels are merely membranes rounded into cylinders. All the ſoft parts of the body, the fibres excepted, ſeem to be an aſſemblage of veſſels, differing from each other only according to the nature of the fluids they contain, and by their number, their direction, and the ſtructure of their coats.

The chemical analyſis of theſe ſubſtances, ſolids as well as fluids, exhibit only a few principles, almoſt all of which are to be found in each of them, though in very different proportions. Some earths, ſome ſalts, phoſphorus, carbon, azote, hydrogen, oxigen, a little ſulphur, and a little iron, combined in a great variety of ways, produce different compoſitions, viz. gelatine, albumen, and fibrous matter, &c. which, uniting in their turn, form animal ſolids and fluids, ſuch as we know them. But, diſtant as we are from a complete analyſis, we ſee enough to convince us, not only that we alter theſe compoſitions by our experiments, but alſo that ſeveral of their principles entirely eſcape our inſtruments.

The general organ by which we exerciſe the faculty of ſenſation, is the medullary ſubſtance. In all the animals in which we can diſtinguiſh it, that ſubſtance is divided into filaments, which, ariſing from certain centres, diſtribute themſelves over moſt parts of the body, where they appear to ſerve other purpoſes beſides that of procuring ſenſations. The centres from which thoſe nervous cords proceed, communicate with each other in a manner more or leſs intimate, and ſeveral of the filaments ſeem of no other uſe than to eſtabliſh thoſe communications.

A nerve, when touched by a foreign body, cauſes the ſenſation of pain, though its contact with the parts of the body which are naturally contiguous to it, produces no ſenſible effect in a ſtate of health. The nerves, by which we diſcern external objects, are provided, at their extremities, with organs, each of which are diſpoſed in a particular manner, and which always poſſeſs an admirable relation to the nature of the objects, a knowledge of which each of theſe ſenſes is deſtined to convey to us.

The general organ of motion is the fleſhy or muſcular fibre. This fibre contracts itſelf by volition; but the will only exerciſes this power through the medium of the nerves.—Every fleſhy fibre receives a nervous filament; and the obedience of the fibre ceaſes, when the communication of that filament with the reſt of the ſyſtem is interrupted. Certain external agents, applied immediately to the fibre, likewiſe cauſe contraction: and they preſerve their action upon it, even after the ſection of its nerve, or its total ſeparation from the body, during a period which is longer or ſhorter in different ſpecies of animals. This faculty of the fibre is called its irritability. Does it in the latter caſe depend upon the portion of the nerve remaining in the fibre after its ſection, which always forms an eſſential part of it? Or is the influence of the will itſelf only a particular circumſtance, and the effect of an irritating action of the nerve on a faculty inherent in the muſcular fibre? Haller and his followers have adopted the latter opinion; but every day ſeems to add to the probability of the oppoſite theory.

Be this as it may, all the internal parts of the bodies deſtined to produce a compreſſion on the ſubſtances they contain, have their parietes furniſhed with fleſhy fibres, and receive nervous filaments; ſuch is the caſe with the arteries, the inteſtines, the heart, &c. But the principal uſe of theſe fibres is the formation of *muſcles*. This is the name given to the bundles of fleſhy fibres, the extremities of which are attached to the moveable parts of the animal body. When the fibres which compoſe the muſcle ſhorten, the two points to which it is attached are brought towards each other: this is the ſole means by which all the external motions of the body and the members, even thoſe which are neceſſary for removing the body entirely from one place to another, are produced.

Animals that can only crawl have their muſcles attached to different parts of their ſkin, on which they alternately produce dilatations and contractions, which are the only motions of which they are ſuſceptible: but thoſe which are capable of moving themſelves by ſteps or otherwiſe, either wholly or partially, have their muſcles attached to hard parts placed externally or internally. Thoſe parts perform the office of levers, and have points of ſupport on each other, which are called their *articulations.*

All the hard parts taken together form the ſkeleton. When they are covered by the muſcles, they receive the name of bone; when they cover muſcles, they are denominated ſhell, cruſt, or ſcale, according to their degree of conſiſtency. In both caſes they always encloſe viſcera, and determine the exterior form of the body, and the proportions of its different parts.

The articulations are provided with as many muſcles as are neceſſary for the different movements of which they are ſuſceptible; each muſcle moving the bone to which it is attached, in its proper direction. They may be regarded as the moving powers. Their force, the point of their inſertion, and the length and weight of the parts attached to the lever they have to move, determine the velocity and the duration of the motion they are capable of producing. On theſe different circumſtances depend the force of leaping, the extent of flight, the rapidity of the race, and the prehenſile power poſſeſſed by different ſpecies of animals; but, as we have already obſerved, all this organization would remain immoveable, were it not animated by the nervous ſyſtem.

The ſoft white ſubſtance which forms the eſſence of this ſyſtem, is divided into filaments that approach each other, and unite in bundles, which contain more filaments in proportion as they are traced nearer to the common faſciculus of all the nerves, called the ſpinal marrow, the anterior extremity of which is joined to the brain, that is to ſay, to a medullary maſs of more or leſs magnitude, and differently formed according to the various kinds of animals.

From the action of external bodies on our own, we perceive that the nerves affected by that action communicate with the common faſciculus, and that it communicates with the brain. A ligature or a rupture intercepts the phyſical communication, and deſtroys ſenſation.

The only ſenſe which belongs generally to all animals, and which pervades almoſt the whole ſurface of the bodies of each of them, is that of feeling. It reſides in the extremities of the nerves which are diſtributed to the ſkin, and makes us ſenſible of the reſiſtance of bodies, and their temperature.

The other ſenſes ſeem to be only modifications of this one, but more exalted, and capable of receiving more delicate impreſſions. Every one knows that the other ſenſes are ſeeing, which reſides in the eye; hearing, which belongs to the ear; ſmelling, which is attached to the membranes within the noſe; and taſting, the ſeat of which is in the ſurface of the tongue. Theſe ſenſes are almoſt always ſituated in the ſame extremity of the body which contains the brain, and which we call the head.

Light, the vibrations of the air, the volatile emanations which float in the atmoſphere, and ſaline particles ſoluble in water, or ſaliva, are the ſubſtances which act on theſe four ſenſes; and the organs, which tranſmit the action to the nerves, are appropriate to the nature of each. The eye preſents tranſparent lenſes to the light, which refract its rays. The ear offers membranes and fluids to the air, which receive its concuſſions. The noſe inhales the air which is to go to the lungs, and ſeizes, in their paſſage, the odoriferous vapours it contains. Finally, the tongue is covered with ſpongy papillæ, which imbibe the ſavory liquids that are taken into the mouth.

By theſe means we obtain a knowledge of what paſſes around us: but the nervous ſyſtem likewiſe makes us acquainted with a great deal of what paſſes within us. Independently of thoſe internal pains which indicate ſome diſorder in our organization, and the diſagreeable ſtate in which we are placed by hunger, thirſt, and fatigue, it is in conſequence of the operation of this ſyſtem that we experience the agonies of fear, the emotions of pity, the deſires of love. Senſations of this laſt kind ſeem, however, to be rather the effects of the re-action of the nervous ſyſtem, than immediate impreſſions; though, at the ſight of any imminent danger, we haſten to avoid it before it appears that the mind has had time to act; and the ſame obſervation applies to the tranſports we feel on the preſence of a beloved object, or to the tears we ſhed over the ſpectacle of ſuffering virtue. Theſe effects of the nervous ſyſtem are produced by numerous communications which particular nerves, called *ſympathetics*, eſtabliſh between different branches of the general trunk, by means of which the impreſſions are tranſmitted more rapidly than by the brain. The knots called *ganglia*, when they are conſiderable, are each a kind of ſecondary brain; and it is obſervable, that they are larger and more numerous in proportion as the principal brain is leſs.

The faculty of ſenſation, and that of contraction, the firſt of which, in moſt animals, is excluſively appropriated to the nervous ſubſtance, and the ſecond to the fleſhy fibre, appears to be equally diffuſed in all the parts of certain gelatinous animals, in which we cannot perceive either fibres or nerves.

It is by the means of theſe two faculties that animals feel, deſire, and are enabled to provide for their wants. The moſt irreſiſtible feeling of all is that of hunger, which conſtantly reminds the animal of the neceſſity of procuring new materials for its nutrition. This third function commences in the mouth, into which the aliments are taken, and, when they are ſolid, maſticated and moiſtened with diſſolving liquors;

thence they traverſe the alimentary canal, which is longer or ſhorter, and more or leſs convoluted and dilated in different animals, and the parietes of which are compoſed of ſeveral continued tunics, analogous to thoſe which form the external teguments of the body.

Theſe coats act in a mechanical manner on the ſubſtances which they contain, by ſlight contractions of their fibres, and in a chemical manner by the liquors which are poured out within them.

The firſt dilatation of the alimentary canal is called the ſtomach. There are ſometimes ſeveral ſtomachs, or ſeveral diviſions of that organ; its parietes yield a liquid which reduces the aliments to a homogeneous pulp, during the time they remain in it. The remainder of the canal is more particularly called bowels or inteſtines. Independently of the juices which the different coats of the bowels produce, there are ſome which are ſeparated from the maſs of blood by glands, and which penetrate the inteſtinal canal by particular conduits. The moſt remarkable and the moſt general of theſe glands are the liver and the pancreas. The firſt, which ſecretes the bile, is always of a conſiderable ſize; and beſides the effect of its liquid on the inteſtines, produces another very remarkable effect on the blood itſelf, from which it removes ſeveral principles.

It is in the inteſtines that the aliments undergo go that change which fits them for nutrition. The nutritive part is abſorbed, during the act of digeſtion, either by the pores of the canal itſelf, in animals that have no circulation, or, in thoſe that have, by very ſmall veſſels which conduct it into the general ſyſtem of nutritive veſſels. Thoſe ſmall veſſels are called *lymphatics*. They are very diſtinct from the veins, in animals whoſe ſtructure moſt reſembles that of man: In the more inferior animals they become gradually more like the veins, and cannot be diſtinguiſhed from them in thoſe which have white blood. The membranes which compoſe the lymphatic veſſels and veins, are thin, and without apparent fibres. Internally they are furniſhed with valves, all opening in the direction in which the fluid they convey has to flow, that is to ſay, towards the heart. The arteries, on the contrary, are ſtrong and muſcular, but have no valves; the vigorous impulſe of the heart is ſufficient to impreſs a conſtant direction on the blood they contain.

But the chyle, or the liquor produced by digeſtion, is not ſufficient for renewing the veinous blood, and rendering it fit for the nutrition of the different parts of the body. It is neceſſary that it ſhould experience the contact of the air before it enter into the arterial ſyſtem. This is effected by reſpiration. The organs of reſpiration, in animals which have blood veſſels, conſiſt in a ramification of thoſe veſſels, which in-

creaſes

creaſes their ſurface to ſuch a degree, that almoſt all parts of the fluid are ſeparated from the ſurrounding element by only a very thin pellicle, which cannot obſtruct its action. This ramification takes place on the ſurface of certain folds or lamellæ in aquatic animals, and on that of certain cells in aerial animals. In the firſt caſe the organ is denominated *branchiæ*, in the ſecond *lungs*. In animals which have no veſſels, the air reaches all parts of the body, and acts on the nutritive fluid at the ſame moment in which that fluid combines with the parts of the body which it is deſtined to nouriſh. This is the caſe with inſects that have *tracheæ*. It will be eaſily conceived that there muſt be muſcular organs appropriated to each of thoſe ſpecies of reſpiration deſtined to attract or impel the ambient fluid towards the place where it has to act upon the blood. This office is performed by the ribs, the diaphragm, the muſcles of the abdomen, the flaps of the gills, and ſeveral other parts, according to the nature of the animal.

The air cannot be employed in the formation of the voice, except in the animals that reſpire by cellular lungs, becauſe it is in them only that it enters by a ſingle and lengthened tube. At one or two parts of this tube there are membranes ſuſceptible of tenſion, which vibrate when the air acts upon them, and thereby produce the various ſounds which we call the *voice*. The animals which have no voice, properly ſo called, are not, however, deprived of the power of producing certain ſounds, but they are produced in them by other means.

The blood, on its paſſage into the organ of reſpiration, experiences a kind of combuſtion, which removes a part of its carbon, carrying it off under the form of carbonic acid, and which thereby augments the proportion of its other elements. The effect of this proceſs on the reſpired air, is to deprive it of its oxygen, which is the only aeriform fluid that can be ſerviceable to reſpiration. Its effect on the blood is leſs known: we know that it heightens the colour of the blood in red-blooded animals, and gives it the power of exciting the heart to contraction. There is even reaſon to believe that it is this action of the air on the blood which gives, indirectly, to the fleſhy fibres their contractile power. It is ſtill neceſſary that the blood ſhould loſe ſeveral other principles: ſome are carried off by the kidneys, which ſecrete the urine, and which are found in all animals that have red blood. The matter which tranſpires through the pores of the ſkin, and the ſubſtances which paſs through the inteſtinal canal, a great part of which are carried away with the excrements, relieve the blood of other principles. Theſe three kinds of excretions, to a certain degree, ſupply the place of each other, and appear, therefore, to tend towards one common object.

Theſe are all the organs which conſtitute the animal, conſidered individually, and which are ſufficient for its ſeparate exiſtence, while the object is not the multiplication of the ſpecies: Such, I ſay, are the whole of the organs in the higher orders of animals. We ſhall ſee that, in proportion as we deſcend in the ſcale of being, they ſucceſſively diſappear, and that at laſt we ſhall find, in the loweſt claſſes, only what is neceſſarily connected with the idea of an animal that is a ſack, ſenſible, moveable, and capable of digeſting.

Upon a cloſe obſervation of the action of all theſe organs, it will appear, that all the operations which take place in the animal body, depend on the combination and decompoſition of the fluids contained within it. To the animal proceſs, by which one fluid is ſeparated from another, or is formed from a part of the elements of one, mixed with a part of thoſe of another, we give the name of *ſecretion:* this term, however, is uſually confined to the changes which take place in different kinds of glands, that is to ſay, in bodies more or leſs thick, in which the blood-veſſels being infinitely ſubdivided, permit the liquid which the gland ſeparates from the blood, to tranſude from their extremities. But the animal œconomy exhibits a number of other transformations, or ſeparations of humours, which equally merit this name. It cannot be ſuppoſed that the nerves act on the muſcular fibres without producing a chemical change on the fluid that may be contained in the one, by the acceſſion of that which the others may tranſmit, nor that external objects act upon the nerves otherwiſe than by producing a change of the ſame kind. The fluid contained in the nervous ſyſtem muſt have been ſeparated from the blood in the brain, and, in general, in all the medullary organ. The blood itſelf does not attain its ſtate of perfection until a multitude of ſubſtances have been detached from it by the lungs, the kidneys, the liver, &c. and until after it has received a number of others which have been ſeparated from the alimentary maſs by the lacteal veſſels: on the other hand, this maſs is not capable of yielding chyle until it has in its turn received different liquors which have been ſecreted from blood by ſeveral organs; and the blood only nouriſhes the parts to which it is diſtributed, by the particles that are detached from its maſs, while other particles are ſeparated from theſe parts to return into the maſs of the blood through the medium of the lymphatic veſſels.

In a word, all the animal functions appear to reduce themſelves to the transformation of fluids. In the manner in which theſe transformations are produced, the real ſecret of the admirable œconomy of animals conſiſts, as health depends upon their perfection and regularity.

If we do not perceive this proceſs in a manner ſufficiently clear when the embryos of new individuals begin to develope themſelves within or without the bodies of their mothers, we can at leaſt diſcover it in the preparation of the male liquor, which, by its preſence, excites or occaſions that development in all the ſpecies in which copulation is neceſſary. This development takes place in the ſame manner as the ordinary growth. It, therefore, comes under the general rule.

The organs of generation, which alone remain to be noticed, are thoſe which prepare the prolific liquor, and convey it to the ova, and thoſe which are deſtined to contain and protect the embryo during its development. The firſt conſtitute the male, the ſecond the female ſex.

The teſticles are the glands which ſecrete the ſeminal fluid; ſeveral other glands prepare liquors which mingle with it. The penis contains the ſeminal canal; it ſwells by the accumulation of blood when the nerves are excited by deſire: by that means, it is rendered capable of penetrating the vagina, which leads to the matrix, or to the *oviductus*, and of conveying thither the fluid deſtined to vivify the ova. The oviduct or tube receives the ovum at the moment in which it is detached from the ovarium; and conducts it without the animal if it be of the oviparous kind, or into the matrix if it be viviparous. The little embryo developes itſelf, and draws its nouriſhment, either from the body of its mother, by the abſorption of a large tiſſue of veſſels connected with thoſe of its own body, or from an organized maſs attached to it in the ſame manner, and which forms the yolk of the egg, or the *vitellus*. When the embryo attains a certain ſtate, the matrix expels it; or it breaks the ſhell of the egg in which it is contained, and eſcapes from its priſon.

ARTICLE III.

View of the Principal Differences which Animals exhibit in their ſeveral Organs.

IT appears from the preceding Article, that what is common to each kind of organs, conſidered in all animals, reſolves itſelf into a very ſmall compaſs, and that frequently they only reſemble one another in the effects they produce. This is particularly obvious with reſpect to reſpiration, which is performed in the different claſſes of animals by organs ſo various, that their ſtructure preſents no common point of compariſon. Thoſe differences in the organs of the ſame kind are preciſely the object of Comparative Anatomy; and the ſhort expoſition we are about to make, of the principal of theſe differences, may be regarded as the general plan of this Courſe of Lectures. We ſhall, therefore, return to each of the functions of which we have treated, and examine the different degrees of energy it poſſeſſes, and the particular means by which it is carried on in different animals.

The organs of motion preſent us at firſt ſight with two important diſtinctions with reſpect to their ſituation. Sometimes the bones form an internal ſkeleton, articulated and covered by the muſcles; ſometimes there are no internal bones, but merely ſcales or ſhells which cover the ſkin, within which are the muſcles: in other caſes there is no hard part that can ſerve as a lever or point of ſupport for the motions of the animal's body.

Animals of the firſt kind have the whole body ſupported by a ſtrong pillar, formed of ſeveral bony pieces placed one above the other, and called the ſpine of the back, or the vertebral column. They are therefore denominated *Vertebral Animals.* Theſe are the *Mammalia, Birds, Reptiles*, and *Fiſhes.*

The animals without vertebræ are either entirely ſoft, or have their bodies and members enveloped in ſcales articulated on one another, or, finally, are encloſed in ſhells. Theſe are the *Soft Worms, Inſects*, and the *Teſtacea.*

It is by the greater or leſs perfection of certain parts that the animals of theſe different claſſes become ſuſceptible of various kinds of motion.

The organs of ſenſation preſent conſiderable varieties—ſome have a relation to the internal part of the nervous ſyſtem, others to the external ſenſes. The firſt gave riſe to three claſſes:—that of animals which have no apparent nervous ſyſtem, and in which we diſcover neither veſſels nor nerves; ſuch are the *Zoophytes* or the *Polyps:*—that of animals in which there is only the brain above the alimentary canal, and which have all the remainder of the common bundle of nerves ſituated underneath, and contained in the ſame cavity with the other *viſcera;* theſe are the *Molluſca*, the *Cruſtacea*, *Inſects*, and a part of the *Articulated Worms:*—laſtly, that of animals in which the common faſciculus of the nerves is ſituated entirely in the back above the alimentary tube, and encloſed in a canal which paſſes through the vertebral column; theſe are all the *Vertebral Animals.* Their ganglia are placed on the ſides of their medullary cord, or diſperſed in the large cavities. Among the invertebral animals there are ſome that have ganglia only in the large cavities, as the *molluſca*, and others which have them all on the medullary cord itſelf, of which they appear to be ſwellings; theſe are the inſects, and ſome articulated worms.

The differences in the external ſenſes conſiſt in their number, and in the degree of energy that belongs to each.

All vertebral animals poſſeſs the ſame ſenſes as man.

Sight is wanting in the zoophytes, in ſeveral kinds of articulated worms, in ſeveral larvæ of inſects, and in the acephalous molluſca. Hearing does not exiſt, at leaſt we have not yet diſcovered its organ in ſome molluſca and inſects. The other three ſenſes, but particularly thoſe of taſte and touch, appear never to be wanting.

But each of theſe ſenſes may vary conſiderably, in the degree of its ſuſceptibility, and the complication of its ſtructure. The perfection of the ſenſe of touch, for example, depends upon the delicacy of the external teguments, and on the diviſion of the extremities that more particularly enjoy that ſenſe; their formation rendering them capable of being applied more or leſs exactly to the bodies of which the animal would acquire a knowledge. Above all, it is in the number and flexibility of the fingers and toes, and the ſmallneſs of the claws or nails, that the anatomiſt diſcovers important characters.

The eyes may be more or leſs moveable, more or leſs covered, and more or leſs numerous. The ears may be ſunk within the cranium, or expoſed outwardly; or they may be provided with an external trumpet, which collects the rays of ſound. The membranes in which the ſenſe of ſmelling reſides may be more or leſs extenſive: thoſe which are the ſeat of taſte, may be more or leſs delicate and humid; but it is only by particularly conſidering each of thoſe ſenſes that we can take a comprehenſive view of the differences that exiſt in the various claſſes of animals.

The organs of digeſtion exhibit two important differences in their general diſpoſitions. In certain animals, (in the greater part of zoophytes,) the inteſtines form a ſack with only one aperture, which ſerves at once for the entrance of the aliments, and the iſſue of the excrements: all other animals have two diſtinct apertures, for thoſe purpoſes, at the two extremities of the ſame canal; but the convolutions of this canal may be ſuch as to remove theſe openings to a greater or leſs diſtance from each other. Another difference which has much influence on the nature of the aliments appropriated to each ſpecies, is, that in certain animals the mouth is armed with teeth, or hard parts proper for grinding ſolid ſubſtances, while in others they do not exiſt. In the latter caſe, the animal can only ſwallow whole bodies if its mouth be large, or merely ſuck in fluids if its mouth be in the form of a tube. The ſtructure of thoſe teeth has itſelf much influence on the ſubſtances the animal can ſubmit to maſtication. The remainder of the alimentary canal varies alſo conſiderably in its ſtructure, according to the different ſubſtances which the mouth conveys to it. On this likewiſe depend the length of the canal, and the member of ſtomachs, cæca, &c. The details on this ſubject muſt, however, be referred to particular articles.

The chyle produced by the action of the digeſtive organs on the alimentary ſubſtances is tranſmitted to the various parts of the body in two different ways. It either ſimply tranſudes through the parietes of the inteſtinal canal, to bathe all the interior of the body, or it is abſorbed by particular veſſels which convey it into the maſs of the blood. The firſt is the mode in which this operation is performed in zoophytes, and, in my opinion, alſo in common inſects, which appear to have no kind of veſſels proper for circulation. As to the other animals, viz. the mollusca, and the vertebral animals, that have abſorbent veſſels, they exhibit two new differences. The latter have red blood, and the lymph and chyle white. Almoſt all the others have theſe two fluids of the ſame colour.

Vertebral animals differ among themſelves, with regard to the colour of the chyle, which is white and opaque in the mammalia, and tranſparent like the other lymph in birds, reptiles, and fiſhes. The three laſt claſſes, therefore, have no conglobate glands in their chyliferous veſſels, while they are very numerous in the firſt.

The circulation of the blood is accompanied with very important differences in its organs. In the firſt place, there are animals which have no circulation whatever, viz. inſects and zoophytes:

others have a double, and others a ſingle circulation. We call that a double circulation in which no part of the veinous blood can enter the arterial trunk, until it has paſſed through the organ of reſpiration, which is generally formed of the ramifications of two veſſels; the one arterial, the other veinous; each nearly as large but not ſo long, as the two principal veſſels of the body. Such is the circulation of man, of all *mammalia*, of *birds*, *fiſhes*, and a number of *mollusca*.

In the ſingle circulation a great part of the veinous blood re-enters the arteries without paſſing through the lung; becauſe only one branch of the arterial trunk is expanded upon that organ; ſuch is the circulation of the *Amphibia*.

There are beſides other differences in the hearts, or muſcular organs, deſtined to give impulſe to the blood. In the ſingle circulation there is only one heart; but, when the circulation is double, there is ſometimes an organ at the baſe of the aorta, and alſo at that of the pulmonary artery. At other times it is at one of the two only.

In the one caſe, the two hearts, or rather the two ventricles, may be united, as in man, mammalia, and birds; or they may be ſeparate, as in the cuttle fiſh.

Where there is only one ventricle, it may be placed at the baſe of the artery of the body, as in ſnails, and other molluſca; or at the baſe of the pulmonary artery, as in fiſhes.

The organs of reſpiration are likewiſe diſtinguiſhed by a number of remarkable differences — When the element that acts on the blood is the atmoſpheric air, it penetrates even into the interior of the reſpiratory organ; but when that element is water, it ſimply glides over a ſurface more or leſs multiplied.

The lamellæ which compoſe the organ, in the latter caſe, are called *branchiæ*. They are found in fiſhes, and in a number of molluſca: inſtead of lamellæ, we ſometimes find fringes or tufts.

The air either enters the body by a ſingle aperture, or by ſeveral. In the firſt caſe, which is that of all animals that have what is properly called lungs, the canal which receives the air divides into a number of branches, terminating in as many ſmall cells, that are uſually united into two maſſes, which the animal has the power of compreſſing or dilating at pleaſure.

When there are ſeveral apertures, which is the caſe only with inſects, the veſſels that receive the air are ramified ad infinitum, and convey it to all parts of the body without exception. This we call reſpiration by *tracheæ.*

Laſtly, the zoophytes, if we except the echinodermata, have no apparent organ of reſpiration.

The organs of the voice preſent only two differences, which may be regarded as general. They depend on the poſition of the *glottis* in which the ſound is formed. In birds, it is at the lower part of the *trachea* or tube, which conducts the air, where it divides into its two branches to paſs into the lungs. In quadrupeds and reptiles it is ſituated in the beginning of the trachea, at the root of the tongue.

Only theſe three claſſes have a glottis; but the other animals produce ſounds by different means. Sometimes they employ the friction of certain elaſtic parts; ſometimes they beat the air with other parts, or produce a rapid motion in certain portions of air, which they ſomewhere retain in their bodies.

Generation gives riſe to varieties of two kinds. The one relates to the actions which occaſion it, the other to the reſult.

In a ſmall number of animals, belonging almoſt entirely to the claſs of *zoophyta*, generation is performed without copulation, and the young animal grows on the body of the parent, like a ſhoot on a tree: others only produce in conſequence of copulation, and are therefore provided with two ſexes; but theſe two ſexes may be ſeparate in different individuals, or united in the ſame. It is only in the molluſca and zoophyta that this laſt caſe occurs: all animals with vertebræ, and inſects, have the ſexes ſeparate.

Hermaphrodite animals, ſuch as the bivalve ſhell fiſh, generate ſingly; in others, a reciprocal copulation take place, each of the two individuals performing the functions of male and female: this is the caſe with the ſnails, and other molluſca that crawl on the belly.

The produce of generation is either a bud which developes itſelf into an animal, remaining ſome time on the body from which it proceeds, and of which it forms as it were a branch; or it is a fœtus, which unfolds itſelf in the uterus of its mother, to which it is connected by a plexus of veſſels, and from which it comes forth alive; or, finally, it is a fœtus incloſed in a ſhell, with a ſubſtance adhering to it by veſſels which it muſt abſorb before it is diſcharged.—Theſe are the *gemmiparous*, *viviparous*, and *oviparous* modes of generation.

The firſt occurs, in ſome zoophytes, and in ſome articulated worms; the ſecond in man and other mammalia only; the third is common to all other animals; and when their young come forth alive from the body of the mother, as is the caſe with the viper, it is becauſe the eggs are hatched in the oviduct.

Laſtly, if we conſider the ſtates through which the young animal is obliged to paſs before it becomes, in its turn, capable of perpetuating its ſpecies, we again diſcover two principal differences.—Some have at their birth the form which they will always preſerve, with the exception of a few inconſiderable parts which have yet to diſcloſe themſelves, and to change their proportions: the others, on the contrary, have a form altogether different from their perfect ſtate, and not only have to produce and unfold new parts, but muſt loſe their old ones: theſe are the animals which undergo a *metamorphoſis.* Hitherto this change has only been obſerved to take place among inſects, and among the reptiles without ſcales, that is to ſay, *frogs* and *ſalamanders.*

Such are the chief varieties which the organs belonging to the ſeveral functions of animals exhibit.

We have, however, yet to notice one very important variety which extends to ſeveral of theſe functions; it relates to the organs of ſecretion. In the four claſſes of vertebral animals, and in ſome molluſca, theſe organs are glands, or at leaſt expanſions of blood veſſels; the name of gland being particularly applied to them when they form maſſes of ſome thickneſs.

It is not ſo in inſects, which, inſtead of ſecretory organs, have only tubes more or leſs long, which attract into the ſpongy texture of their parietes, that portion they have to ſeparate from the maſs of the nutritive fluid.

We are as yet little acquainted with the organs of ſecretion in zoophytes, if indeed they can be ſaid to have any particular organ for that purpoſe.

Article IV.

View of the Relations which exiſt amongſt the Variations of the ſeveral Organs.

The preceding Article has pointed out the principal differences of which the organs, belonging to each animal function, are ſuſceptible in their ſtructure and operation. The number of theſe differences would have been much greater had we entered into details, and deſcended to the leſs important circumſtances.—It is obvious, however, from the manner in which we have deſcribed them, that, by ſuppoſing each of the differences of one organ united ſucceſſively with thoſe of every other, there would be produced a very conſiderable number of combinations, which would correſpond with as many claſſes of animals. But theſe combinations which appear poſſible, when we conſider them abſtractedly, do not all exiſt in nature; becauſe, in a ſtate of life, the organs do not ſimply join their effects, but act on each other, and concur altogether to one common object. Hence the modifications of any one of them exerciſe an influence on thoſe of every other. Such of theſe modifications as cannot exiſt together, reciprocally exclude one another, while others are, as it were, called into the ſyſtem; and this takes place, not only in the organs which have an immediate connexion, but in thoſe which at the firſt view appear the moſt ſeparate and independent.

In fact there is not one function which does not ſtand in need of the concurrence of almoſt all the others, and which is not more or leſs affected by their degree of energy.

Reſpiration, for example, cannot take place without the aid of the motion of the blood, ſince it conſiſts in bringing that fluid in contact with the ſurrounding element; but as it is circulation that gives motion to the blood, it therefore is a neceſſary mean in producing reſpiration.

Circulation itſelf has its cauſe in the muſcular action of the heart and arteries: it is produced, therefore, by the aid of irritability. That faculty, in its turn, derives its origin from the nervous fluid, and, conſequently, from the function of ſenſibility which returns, by a kind of circle to the circulation of the blood, which is the cauſe of all the ſecretions, and of that of the nervous fluid as well as others.

Of what value would ſenſibility be, were it not aided by the muſcular force, even in the moſt trifling circumſtances? What would be the utility of the ſenſe of feeling, were we not able to turn our hands towards palpable objects? And what would be the advantage of ſeeing, if we could not turn the head or eyes in every direction?

It is on this mutual dependance of the functions, and the aid they reciprocally yield to one another, that the laws which determine the relations of their organs are founded—laws which have their origin in a neceſſity equal to that of metaphyſical or mathematical laws: for it is evident that a ſuitable harmony between organs which act on one another, is a neceſſary condition of the exiſtence of the being to which they belong; and that if any one of the functions were modified in a manner incompatible with the regulations of the others, that being could not exiſt.

We are about to take a view of the moſt remarkable of theſe relations, by entering into a compariſon of the different functions of animals. To begin with one of the moſt obvious: we obſerve that the mode of reſpiration conſtantly depends on the manner in which the motion of the nutritive fluid is performed. In animals that have a heart and veſſels, this fluid is continually collected in a central reſervoir, whence it is forcibly impelled towards all the parts of the body. It always comes from the heart, and always returns thither before it reviſits the other parts. It can, therefore, be expoſed to the action of the air at its ſource; and, in fact, before it returns through the aorta and its ramifications to the parts which it has to nouriſh, it paſſes through lungs or branchiæ, to be there ſubjected to that action. But this is not the caſe with the animals, which, like inſects, have neither heart nor blood veſſels: their nutritive fluid has no regular motion, and departs from no common ſource. It is not poſſible that it ſhould be prepared in a ſeparate organ before it is diſtributed to the reſt of the body, ſince, ariſing like a dew from the pores of the inteſtinal canal, it conſtantly bathes all the parts; and ſince theſe parts always receive from it the particles which are depoſited between thoſe of which they are already conſtituted. The action of the air, therefore, can only be exerciſed at the time and place of this depoſition. This operation takes place very perfectly by the diſpoſition of the tracheæ; there being no ſolid point in the body of inſects where the fine ramifications of theſe aerial veſſels are not attached, and on which the air does not immediately exerciſe its chemical effect. As we clearly ſee the cauſes of this relation between the organs of theſe two functions, we are authorized to preſume that other relations equally conſtant, which exiſt between them, have alſo their foundation in cauſes of the ſame kind, though they are not ſo evident to us.

Thus, among the animals that have blood-veſſels, and enjoy a double circulation, thoſe which reſpire the air by receiving it immediately into the cellular lungs, have always the two trunks of their arteries approximated, and furniſhed with muſcular ventricles, but joined together in one maſs; while thoſe which reſpire only through the medium of the water that paſſes between the folds of their branchiæ, have always two ſeparate trunks, whether they be both provided with ventricles as the *Sepia*, or have a ventricle for one only, like fiſhes and molluſca.

We can more readily perceive the reaſon of the relations which connect the mode and extent of reſpiration, with the different kinds of general motion of which each animal is ſuſceptible, and which render the air more neceſſary to them in proportion as their manner of moving enables them to procure it with facility; or, what amounts to the ſame thing, thoſe which can the moſt eaſily obtain pure air, are preciſely thoſe to whom reſpiration is moſt indiſpenſably neceſſary.

Modern experiments have demonſtrated, that one of the principal uſes of reſpiration is to reanimate the muſcular force, by reſtoring to the fibre its exhauſted irritability. We, indeed, obſerve, that the animals which reſpire immediately, and have a double circulation, and in which none of the veinous blood can return to the various parts until after reſpiration, that is to ſay, birds and mammalia, not only always live in air, and move in it with greater force than the other red-blooded animals, but each of thoſe claſſes enjoys the faculty of motion preciſely in a degree correſponding to its quantity of reſpiration. Birds which are, as it were, alway in the air, are, if I may be allowed the expreſſion, equally impregnated by that element both internally and externally. The cellular part of their lungs is not only very conſiderable, but theſe organs have ſacks and appendices which are prolonged throughout the body. Birds therefore conſume, within a given time, a much greater quantity of air, in proportion to their bulk, than quadrupeds. Doubtleſs this is the circumſtance which gives to their fibres an inſtantaneous force ſo very prodigious, and which renders their fleſh capable of becoming the moving power in machines which require actions ſo violent as to ſuſtain them in the air by the ſimple vibration of wings.

With reſpect to the force of their motion, and quantity of reſpiration, the mammiferous animals ſeem to hold a middle place between birds and reptiles, which form the oppoſite extremes. With the latter, reſpiration appears to be only an acceſſary circumſtance; they may diſpenſe with it almoſt as long as they pleaſe. Their pulmonary veſſels are merely branches of the great trunks. On the one part their organs of motion reduce them to remain on the earth, in obſcure and cloſe places, in the midſt of foul air: and their inſtinct frequently directs them to ſhut themſelves up in cavities in which the air cannot be renewed, or even to bury themſelves under water during a great portion of the year: on the other part, their motion is in general very ſlow; and they paſs a great part of their life in a ſtate of complete repoſe.

As it is one of the conditions of the exiſtence of every animal, that its wants ſhould be proportioned to the ability it poſſeſſes of ſatisfying them, irritability remains longeſt unexhauſted in thoſe caſes in which reſpiration is leaſt prompt and efficacious in repairing it. This ſuggeſts the cauſe why reptiles are ſo remarkable for irritability; and why their fleſh palpitates ſo long after they are dead, while thoſe animals that have warm blood loſe that quality as their blood becomes cold.

This relation of the extent of the motive power to the action of the ambient element, is confirmed by the example of fiſhes, which having cold blood like reptiles, have alſo, like them, little muſcular force, and an irritability capable of a long duration. The velocity with which ſome of them ſwim, muſt not deceive us in this reſpect; becauſe, being then placed in an element as heavy as themſelves, no force is requiſite for their ſupport.

If, however, their reſpiration have the ſame reſult as that of reptiles, that reſult is obtained by other means. Their circulation, indeed, is double, like that of warm-blooded animals: but as it is air mixed with water which acts on their blood, it is neceſſary that the little activity of the element ſhould be counterbalanced by the prompt return of the blood into the pulmonary organ. Here we find a new relation between the modifications of the reſpiratory organs and thoſe of circulation. Animals of every claſs which reſpire by branchiæ, and through the medium of water, have always a double circulation; while, of thoſe that reſpire the air directly, ſeveral have a ſingle circulation, that is, thoſe which do not require an exceſſive irritability: but it appears that an inferior degree would have been inſufficient to preſerve the muſcular force, and that the union of theſe two modes, which both weaken the effect of reſpiration, would have prevented the renewal of the energy of the fibre.

The nervous ſyſtem has likewiſe its relations to reſpiration with reſpect to the varieties obſerved in both thoſe functions. The external ſenſes have much leſs energy, and the brain is conſiderably ſmaller in the animals that have cold blood, in which that organ occupies only a ſmall part of the cranium, than in thoſe of warm blood, in which the brain fills the whole cavity. Doubtleſs, the little irritability of the fibre in thoſe animals requires but a ſmall degree of activity in the organs that put it in motion: lively ſenſations and ſtrong paſſions would have too much exhauſted their muſcular force. In this manner the organs of ſenſation are immediately connected with thoſe of reſpiration.

But to what ſecret cauſe is it owing, that in all the animals which reſpire by diſtinct organs, the medullary maſſes form a ſmall number, and are collected in the cranium, or, at leaſt, detached from the ſpinal marrow, while in thoſe that reſpire by tracheæ, nearly equal ganglions are diſtributed throughout the whole extent of their nervous cord? How does it happen, too, that there is no nervous ſyſtem apparent in animals which have no organs particularly deſigned for reſpiration? Theſe two relations muſt be included amongſt thoſe whoſe cauſes are unknown to us.

Digeſtion, alſo, has its connection with reſpiration: the latter being one of the functions which conſume and expel, with the greateſt rapidity, the ſubſtances of which the body is compoſed, the digeſtive power is generally the greater in proportion as reſpiration is more complete, in order that the quantity which is acquired may be equal to that which eſcapes.

In conſequence of the connection that ſubſiſts between the organs of reſpiration and the modifications of ſeveral other functions, ſome of the latter have relations to one another which at firſt ſight did not appear neceſſary. This is the reaſon why birds have in general an exceedingly ſtrong ſtomach, and a very quick digeſtion. This alſo is the reaſon why their repaſts are ſo frequently repeated; while reptiles, which among the red-blooded animals ſeem to be contraſted to them in every reſpect, aſtoniſh us by the little aliment they take, and the length of time they abſtain from food. Theſe differences in the digeſtive powers do not depend upon the nature of the organs of motion which characteriſe theſe two claſſes, but upon that of the organs of reſpiration, the modifications of which have an immediate relation with thoſe of motion.

It is eaſy to perceive that theſe two very different degrees of digeſtive powers depend on two diſpoſitions equally different in the alimentary organs, and that each of theſe diſpoſitions muſt be co-exiſtent with a correſponding one in the reſpiratory organs. The latter alſo being always connected with a diſpoſition equally determined in the organs of motion, in thoſe of ſenſation, and in thoſe of circulation, each of thoſe five ſyſtems of organs may be ſaid to regulate and govern the others.

The ſyſtem of digeſtive organs has alſo immediate relations with thoſe of motion and ſenſation. The diſpoſition of the alimentary canal determines, in a manner perfectly abſolute, the kind of food by which the animal is nouriſhed; but if the animal did not poſſeſs, in its ſenſes and organs of motion, the means of diſtinguiſhing the kinds of aliment ſuited to its nature, it is obvious it could not exiſt.

An animal, therefore, which can only digeſt fleſh, muſt, to preſerve its ſpecies, have the power of diſcovering its prey, of purſuing it, of ſeizing it, of overcoming it, and tearing it in pieces. It is neceſſary, then, that this animal ſhould have a penetrating eye, a quick ſmell, a ſwift motion, addreſs, and ſtrength in the claws

and

and in the jaws. Agreeably to this neceſſity, a ſharp tooth, fitted for cutting fleſh, is never coexiſtent in the ſame ſpecies, with a foot covered with horn, which can only ſupport the animal, but with which it cannot graſp any thing; hence the law by which all hoofed animals are herbivorous; and alſo thoſe ſtill more detailed laws which are but corollaries of the firſt, that hoofs indicate dentes molares, with flat crowns, a very long alimentary canal, a capacious or multiplied ſtomach, and ſeveral other relations of the ſame kind.

Thoſe laws which determine the relations of the organs belonging to the different functions, likewiſe exerciſe their powers on the different parts of the ſame ſyſtem, and connect its variations with equal force. The application of theſe laws is particularly evident in the alimentary ſyſtem, the parts of which are more numerous and diſtinct. The form of the teeth, the length, the convolutions, and the dilatations of the alimentary canal, and the number and abundance of the diſſolving liquors poured into it, have always an admirable relation to each other, and to the nature, the hardneſs, and the ſolubility of the ſubſtances the animal eats. This connection is ſo evident, that the ſkilful anatomiſt, upon knowing one of thoſe parts, may eaſily conjecture moſt of the others, and may, agreeably to the preceding laws, even gueſs the extent of the other functions.

The ſame harmony exiſts between all parts of the ſyſtem of the organs of motion; as each of thoſe organs acts upon the reſt, and experiences their action in its turn, particularly when the animal is completely in motion, all their forms have relation to one another. Not a bone is varied in its ſurfaces, in its curvatures, or in its eminences, without ſubjecting the other bones to proportionate variations: we may, therefore, on the view of one of them, form, with a certain degree of accuracy, an idea of the whole ſkeleton.

Theſe laws of co-exiſtence, which we have thus far pointed out, may be ſaid to be reduced by reaſoning from the knowledge we have of the reciprocal uſes and functions of each organ. Obſervation having confirmed theſe laws, we are authoriſed to follow an oppoſite courſe under other circumſtances; when, therefore, we obſerve conſtant relations of form, between certain organs, we may conclude that they exerciſe ſome influence on one another, and we may even make pretty accurate conjectures as to the uſes of both. Thus the conſiderable magnitude of the liver in thoſe animals which reſpire leaſt, and its total abſence in inſects, which poſſeſs the moſt complete kind of reſpiration, ſince their whole body forms as it were their lungs, have induced us to conclude that the liver, in a certain degree, ſupplies the place of the lungs, and, like them, ſerves to remove from the blood its two combuſtible principles.

In this manner we account for the whiteneſs and opacity of the chyle in ſome animals, while in others it is as tranſparent as lymph, when we know that the firſt are all thoſe which have mammæ, and ſuckle their young. It is only by a profound ſtudy of thoſe relations, and by the diſcovery of thoſe which have hitherto eſcaped our obſervation, that we can hope to extend phyſiology. Comparative anatomy may, therefore, be regarded as one of the richeſt ſources of obſervation for perfecting that important branch of knowledge.

Nature never overſteps the bounds which the neceſſary conditions of exiſtence preſcribe to her; but whenever ſhe is unconfined by theſe conditions, ſhe diſplays all her fertility and variety. Never departing from the ſmall number of combinations that are poſſible, between the eſſential modifications of important organs, ſhe ſeems to ſport with infinite caprice in all the acceſſary parts. In theſe there appears no neceſſity for a particular form or diſpoſition. It even frequently happens, that particular forms and diſpoſitions are created without any apparent view to utility. It ſeems ſufficient that they ſhould be poſſible, that is to ſay, that they do not deſtroy the harmony of the whole. In proportion, therefore, as we turn our attention from the principal organs to thoſe which are leſs important, we diſcover increaſing variations; and when we arrive at the ſurface of bodies where the nature of things requires that the parts leaſt eſſential, and the injury of which is leaſt dangerous, ſhould be placed, the number of varieties becomes ſo conſiderable, that all the labours of naturaliſts have not yet been able to give us an account of them.

Among theſe numerous combinations there are neceſſarily many which have common parts, and there is always a certain number which exhibits very few differences; by the compariſon therefore of thoſe which reſemble each other, we may eſtabliſh a kind of ſeries, which will appear to deſcend gradually from a primitive type. Theſe conſiderations are the foundations of the ideas from which certain naturaliſts have formed *A Scale of Being*, the object of which is to exhibit the whole in one ſeries, commencing with the moſt perfect, and terminating with the moſt ſimple kind of organization—with that which poſſeſſeſs the leaſt numerous and moſt common properties; ſo that the mind paſſes from one link of the chain to the other, almoſt without perceiving any interval, and, as it were, by inſenſible ſhades.

Indeed, when we confine ourſelves within certain limits, and particularly when we conſider each organ ſeparately, and follow it through all the ſpecies of one claſs, we obſerve that its progreſſion in the ſcale is preſerved with a ſingular regularity; we even perceive the organ partially, or ſome veſtige of it in ſpecies, in which it is no longer of any uſe; ſo that Nature ſeems to have left it there only to ſhew how ſtrictly ſhe adheres to the law of doing nothing by ſudden tranſitions: but, on the one hand, the organs do not all follow the ſame order of gradation; one is found in its higheſt degree of perfection in one ſpecies, while another is moſt perfect in a ſpecies altogether different. If, therefore, we were to claſs the different ſpecies according to each organ conſidered ſeparately, it would be neceſſary to form as many ſeries as we ſhould adopt regulating organs; and to make a general ſcale of perfection, it would be neceſſary to calculate the effect reſulting from each combination. This, however, is far from being practicable.

On the other hand, the gentle and inſenſible ſhades of gradation prevail ſo long as we confine ourſelves to the ſame combination of the principal organs, and ſo long as the great central ſprings remain the ſame. All the animals in which this takes place, ſeem to be formed upon one common plan, which ſerves as the baſis of all the little external modifications: but the moment we turn our attention to thoſe animals in which other principal combinations take place, there is no longer any reſemblance, and an interval or marked tranſition is obvious to every one.

Whatever arrangement may be given to vertebral animals, and thoſe which have no vertebræ, we never ſhall ſucceed in placing at the bottom of one of thoſe great claſſes, and at the head of the other, two animals which ſufficiently reſemble each other to ſerve as a link between them.

ARTICLE V.

Diviſion of Animals founded on the whole of their Organization.

IT is the object of Comparative Anatomy to point out the differences which each organ preſents when conſidered in every animal; but this expoſition would prove very tedious and intricate, were we obliged at every ſtep to enumerate all the animals in which particular organs have a uniform ſtructure. It is certainly much more convenient to indicate them all at once, under the name of a claſs or genus, which may comprehend the whole: but to enable us to form this arrangement, it is neceſſary that all the animals which compoſe a genus or claſs, ſhould poſſeſs ſome reſemblance not only in one, but in all their organs; otherwiſe we ſhould be obliged to adopt new claſſes and new genera, and a particular nomenclature every time we treated of a particular organ, by which a greater degree of confuſion would be produced than that we are deſirous of avoiding. But this confuſion would certainly prevail, were we to take the characters of the ſubdiviſions of the different gradations from organs, and modifications of organs, choſen arbitrarily and at hazard. Though the organ ſelected ſhould be found among the leaſt important, and among thoſe which have the leaſt influence on the whole, it does not follow that the other organs would reſemble one another in all the animals in which the likeneſs of this one might be preſerved. Nothing, therefore, could be affirmed reſpecting the other organs belonging to the whole of a claſs or genus of animals, which we ſhould have attempted to diſtinguiſh by characters taken from this unimportant organ.

Suppoſe, for example, that we had made three diviſions of animals, the aerial, terreſtrial, and aquatic, as they were anciently claſſed; there would be included, in the firſt claſs, beſides what are commonly called birds, ſome mammiferous animals, (as bats;) ſome reptiles, (as the dragon;) ſome fiſhes, (the different kinds of flying fiſh;) and a multitude of inſects. Similar difficulties would occur in a greater or leſs degree in the other two claſſes. If, therefore, we had to deſcribe one of their organs, the liver for inſtance, it would not be poſſible to find a ſingle quality which we could attribute to it, throughout the whole of one claſs, nor one which could be ſaid to belong to it peculiarly in any one of the three claſſes, to the excluſion of the other two.

This example is well calculated to ſhew how important it is that the characters of our diviſions ſhould be well choſen; for, though in the formation of methods and ſyſtems of natural hiſtory, errors ſo flagrant as the above are not now committed, ſeveral naturaliſts, even in modern times, have adopted diviſions which, in the detail, lead to ſimilar reſults.

The object of every good method is to reduce a ſcience to its ſimpleſt terms, by reducing the propoſitions it comprehends to the greateſt degree of generality of which they are ſuſceptible. A good method in comparative anatomy muſt, therefore, be ſuch as will enable us to aſſign to each claſs, and to each of its ſubdiviſions, ſome qualities common to the greater part of the organs. This object is to be attained by two different means, which may ſerve to prove or verify one another. The firſt, and that to which all men will naturally have recourſe, is to proceed from the obſervation of ſpecies to uniting them in genera, and to collecting them into a ſuperior order, according as we find ourſelves conducted to that claſſification by a view of the whole of their attributes. The ſecond, and that which the greater part of modern naturaliſts have employed, is to fix, before-hand, upon certain baſes of diviſion, agreeably to which, beings, when obſerved, are arranged in their proper places.

The firſt mode cannot miſlead us; but it is applicable only to thoſe beings of which we have a perfect knowledge: the ſecond is more generally practiſed; but it is ſubject to error. When the baſes that have been adopted remain conſiſtent with the combinations which obſervation diſcovers, and when the ſame foundations are again pointed out by the reſults deduced from obſervation, the two means are then in uniſon, and we may be certain that the method is good.

But when it is not poſſible to employ the firſt means, it becomes neceſſary to calculate the importance of the diſtinctions we adopt, in which we are much aſſiſted by conſidering the conſequence of thoſe organs upon which they are founded. Naturaliſts have not been inattentive to theſe principles, and upon them they have eſtabliſhed their diſtinctions between the organs of the firſt, ſecond, third rank, &c.

It would have been better, however, had they directed their inquiries rather to the functions themſelves than to the organs; for all the parts, all the forms, all the qualities of an organ of the firſt rank, are not equally calculated to furniſh characters for the ſuperior claſſes: the only forms and qualities fitted for this purpoſe, are thoſe which modify, in an important manner, the function to which the organ belongs; thoſe which may be ſaid to give it a new direction, and to produce new reſults. All the other conſiderations to which an organ, whatever be its rank, may give riſe, are of no importance, ſo long as they do not directly influence the functions it exerciſes. In this reſpect ſome naturaliſts have been miſled: they have believed that every thing was important in an important organ, and have therefore, without any juſt reaſon, rejected well-formed diviſions: this, however, is not the place to diſcuſs thoſe principles, and ſtill leſs to apply them. The formation of ſyſtems is the object of natural hiſtory, properly ſo called: Anatomy receives them, as it were, ready made; the latter takes its firſt direction from the former, but is not ſlow in reflecting back the light it has received. By applying a ſyſtem of natural hiſtory to comparative anatomy, we are ſpeedily enabled to diſcover whether it deviates from the path of nature.

We ſhall, therefore, turn our attention to the whole of the animal kingdom, and endeavour to diſcover what is common in the organization of each of the families of the different claſſes into which it is divided. This general review is further neceſſary to us for another object: in the deſcriptions we ſhall have to make, in the ſucceeding Lectures, of the different organs, and their various conformations, we ſhall frequently have occaſion to refer to the ſeveral genera and families of animals. It is therefore neceſſary that we ſhould poſſeſs, at leaſt, a ſummary knowledge of them; and this the following examination may enable us to procure.

The whole animal kingdom is, in the firſt place, divided into two great families:—1ſt. That of the animals which have vertebræ, and red blood: 2d, That of the animals without vertebræ, almoſt all of which have white blood.

The firſt have always an internal articulated ſkeleton, the principal ſupport of which is the vertebral column which joins the head at its anterior extremity, and incloſes, in its conduit, the common faſciculus of the nerves: its poſterior extremity is frequently prolonged to form the tail: the ribs, which are almoſt always found in animals of this claſs, are attached to both ſides of this column. There are never more than four members; two, or all of which, ſometimes may, however, be wanting.

The brain is always contained in a particular oſſeous cavity of the head, called the cranium. All the nerves of the ſpine contribute, by filaments, to the formation of a nervous plexus, which derives its origin from ſome of the nerves of the cranium, and is diſtributed over moſt of the viſcera.

The ſenſes are always five in number. The eyes are two, and moveable at will. The ear has at leaſt three ſemicircular canals. The ſenſe of ſmelling reſides excluſively in the cavities in the fore-part of the head.

The circulation is always maintained by a heart, conſiſting of at leaſt one fleſhy ventricle: and when there are two ventricles, they are never ſeparate. The lymphatic veſſels are diſtinct from the veins.

The two jaws are placed horizontally; and the mouth always opens by their ſeparation from above downwards. The inteſtinal canal is continued from the mouth to the anus, which is uniformly ſituated in the back of the pelvis, that is to ſay, behind the bones which ſupport the poſterior extremities. The inteſtines are ſurrounded with a membranous covering called the peritonæum. There is always a liver and a pancreas which ſecrete diſſolving liquors, and a ſpleen, in which a part of the blood which proceeds to the liver undergoes a previous preparation.

There are always two kidneys for the ſecretion of the urine, ſituated on each ſide of the ſpine, and without the peritonæum. The teſticles are two in number. Above the kidneys there are always two bodies, the uſe of which is not yet known:—they have been named *capſulæ atrabilariæ.*

The vertebral animals are ſubdivided into two branches, thoſe with warm blood, and thoſe with cold blood.

The animals that have vertebræ and warm blood, have always two ventricles to the heart, and a double circulation. They breathe by lungs, and cannot exiſt without reſpiration. Their brain fills up exactly the cavity of the cranium. Their eyes cloſe by palpebræ. Their ear has its tympanum ſunk in the ſkull. All the parts of the labyrinth are cloſely enveloped by the bones; and in it we always find, beſides the ſemi-circular canals, an organ with two cavities reſembling the ſhell of a ſnail. Their noſtrils communicate with the back of the mouth, and ſerve as paſſages to the air in reſpiration. Their trunk is always ſurrounded with ribs; and almoſt all of them have four members.

It is by privations, rather than by common properties, that the vertebral animals with cold blood are to be compared. Several of them are deſtitute of ribs; others have no members. Their brain never occupies all the cavity of the cranium. Their eyes very rarely have moveable palpebræ. The tympanum of their ear, if it exiſt, is always level with the head: it is often wanting, as well as the oſſicula auditus. The cochlea is always wanting. The different parts of the ear are not attached cloſely to the cranium; they are even frequently at liberty in the ſame cavity with the brain.

Each of theſe two branches is divided into two claſſes. Thoſe of the animals with warm blood are *mammalia* and *birds*.

The mammiferous animals are viviparous, and nouriſh their young with milk, which is ſupplied by their mammæ: they have always an uterus, with two cornua; the males have always a penis, which, in copulation, they introduce into the female organ of generation.

Their head is joined to the firſt vertebræ by two eminences. The vertebræ of the neck are never leſs than ſix, nor more than nine. Their brain is more complicated than that of other animals: it has parts which are not found in the other claſſes; ſuch as the *corpus calloſum*, the *fornix*, the *pons varolii*, &c.

Their eyes have only two palpebræ; their ear has four little articulated bones, and a cochlea truly ſpiral; their tongue is entirely ſoft and fleſhy. The ſkin of the greater number is covered with hair, and there is at leaſt ſome hair on all of them.

Their lungs are encloſed within the thorax, which is ſeparated from the abdomen by a fleſhy diaphragm: they have but one larynx, ſituated at the baſe of the tongue, and covered by an epiglottis while the animal ſwallows.

The lower jaw only is moveable: both jaws are furniſhed with lips.

Their biliary and pancreatic ducts are inſerted at the ſame point. Their lacteal veſſels contain a white milky chyle, and traverſe a multitude of conglobate glands, ſituated in the myſentery. A membrane, called the epiploon, ſuſpended at the ſtomach and neighbouring parts, covers the inteſtines anteriorly. The ſpleen is always ſituated on the left ſide, between the ſtomach, the ribs, and the diaphragm.

The *birds* are oviparous. They have but one ovarium, and one oviduct—a ſtructure which is entirely peculiar to this claſs. They have the head connected with the firſt vertebræ of the neck by one eminence only: the cervical vertebræ are very numerous; the ſternum is very broad; the anterior members are only uſed in flying, the poſterior in walking.

Their eyes have three palpebræ: they have no external ear, and their tympanum has only one bone; their cochlea is conical, and ſlightly twiſted; their tongue has a bone internally; the body is covered with feathers; the lungs are attached to the ribs; and the air, in paſſing through them, is communicated to all the body, as the animals of this claſs have no diaphragm. Their trachea has a larynx at each of its extremities; the ſuperior has no epiglottis: their mouth is a bill, or beak, of a horny conſiſtence, the two mandibles of which are moveable.

Several ducts proceed from the pancreas and liver, and enter the inteſtinal canal at different points. The chyle is tranſparent; and there are no myſenteric glands, nor omentum. The ſpleen is in the centre of the myſentery. The ureters terminate in a cavity called the cloaca, which is common to the excrements and to the eggs. They have no urinary bladder.

The claſſes of vertebral animals, that have cold blood, are *reptiles* and *fiſhes.*

Reptiles differ with reſpect to one another in ſeveral very important points, and have not, perhaps, common qualities in ſo great a number as the other claſſes: ſome of them walk, ſome fly, others ſwim, and a great number can only crawl. Their organs of ſenſation, particularly the ear, vary almoſt as much as thoſe of motion; they have, however, no cochlea; their ſkin is either naked, or covered with ſcales; their brain is always very ſmall; their lungs float in the ſame cavity with the other viſcera, but do not ſuffer the air to paſs beyond them. The cells of the lungs are very large: there is only one larynx, which has an epiglottis; the two jaws are moveable; they have no omentum, nor myſenteric glands; their ſpleen is in the centre of the myſentery: the female has always two ovaries, and two oviducts; they have an urinary bladder.

Fiſhes reſpire by organs in the form of combs, placed on both ſides of their neck, between which they tranſmit the water: they have, therefore, neither trachea, larynx, nor voice; their body is adapted to ſwimming, but their fins are ſometimes wanting. Beſides the four which repreſent the extremities, they have vertical fins on the back, under the tail, and at its extremity.

Their noſtrils are of no uſe in reſpiration;

their ear is entirely concealed within the cranium; their ſkin is naked, or covered with ſcales; their tongue is bony; their two jaws are moveable; the pancreas is frequently replaced by *inteſtinula cæca*; they have an urinary bladder: the ovaries are double.

The invertebral animals have not ſo many qualities in common, and form a leſs regular ſeries than thoſe of which we have ſpoken. If they have hard parts, however, they are generally external, at leaſt when they are articulated. Their nervous ſyſtem has not its connecting parts encloſed in a bony caſe, but floats in the ſame cavity with the other viſcera.

There is only a brain above the alimentary canal: it furniſhes two branches, which envelope the œſophagus, like a collar, and the continuation of which forms the remainder of the common bundle of the nerves.

They never reſpire by cellular lungs, and none of them have any voice: their jaws have all kinds of directions, and frequently their mouths are only ſuckers; they have neither kidneys nor urine: if they have articulated members, they are always at leaſt ſix in number. Conſidered anatomically, they ought to be divided into five claſſes.

The *molluſca* form the firſt.

In them the body is ſoft, fleſhy, and deſtitute of articulated members; though ſometimes there are hard parts placed internally: and though frequently it is covered externally with hard ſhells, they have arterial and veinous veſſels, in which the blood undergoes a real circulation.

They reſpire by branchiæ. Their brain is a diſtinct maſs, from which proceed the nerves, and a medulla oblongata. They have ganglions in different parts of the body.

Their external ſenſes vary as to number. In ſome the eyes and ears are very perceptible, while others appear to enjoy the ſenſes of taſting and touch only. There are many that can maſticate, and others that can only ſwallow.

They have a voluminous liver, which furniſhes a great quantity of bile. Their organs of generation are exceedingly various.

The *cruſtacea* form the ſecond claſs.

In them the body is covered with ſcaly pieces. They have frequently a conſiderable number of articulated members. Their nervous ſyſtem conſiſts of a long knotted cord, from the ganglions of which all the nerves proceed.

We find in them hard moveable eyes, compoſed of different parts; and ears are diſcovered which are very imperfect. They have for the ſenſe of touch, antennæ and feelers like inſects. They have a heart with arterial and veinous veſſels, and branchiæ for reſpiration: their jaws are tranſverſe, ſtrong, and numerous; the ſtomach has internal teeth; a number of inteſtinula cæca ſupply a brown fluid, which anſwers inſtead of bile. The male has two penes, the female two ovaria.

The *inſects* form the third claſs.

In their perfect ſtate, they have antennæ and articulated members like the cruſtacea. The greater part have wings, which enable them to fly; and theſe have all paſſed through other ſtates of exiſtence, one of which is frequently completely motionleſs. They all have a nervous ſyſtem, ſimilar to that of the cruſtacea; but they have neither heart nor veſſels, and reſpire only by trachea. Not only the liver, but all the ſecretory glands, are in them replaced by long veſſels which float in the abdomen. The form of the inteſtinal canal is frequently very different in the ſame individual, as the inſect paſſes through its three ſtates.

The animals which reſemble the larvæ of inſects, and have, like them, a knotted medullary cord, might be joined with inſects, though they do not undergo a metamorphoſis; ſome of them, however, have blood veſſels very diſtinct, and ought, therefore, to form a ſeparate claſs, intermediate between the *molluſca*, the *cruſtacea*, and *inſects*; ſuch are the *terreſtrial worms* and *leeches*.

This is the fourth claſs: the *zoophyta* form the fifth.

The parts of the body in this laſt claſs are formed like a ſtar, or the radii of a circle, in the centre of which the mouth is placed. They have neither heart nor blood-veſſels, and we cannot perceive in them either brain or nerves.

We muſt now return to each of the nine principal claſſes which form the animal kingdom, and divide them into families of a leſſer order.

The mammalia exhibit, in the firſt place, an order, the ſpecies of which are deprived of the poſterior feet, and have the neck ſo ſhort, and the tail ſo thick, that, at firſt ſight, we would be inclined to claſs them with fiſhes. They live conſtantly in water, though they can only reſpire in air; but their noſtrils open at the ſummit of their head, which enables them to inhale the air, without raiſing the mouth out of the water. Theſe noſtrils alſo ſerve them in expelling the ſuperfluous water, which they take in at their mouth every time they attempt to ſwallow their prey; they are, therefore, ill calculated for exerciſing the ſenſe of ſmelling, for which nature has formed particular cavities.

The *cetacea*, which is the name given to this order of mammalia, have a ſmooth ſkin, which covers a great maſs of fat. They have no external ear: their teeth, which ſerve to retain their prey, and not to maſticate, are ſometimes replaced by laminæ of horn. The ſtomach is multiplied; the inteſtinal canal is uniform, and has no cæcum; the kidneys are much divided; they have lungs, and a liver, the lobes of which are not very numerous: the larynx is of a pyramidal form, and opens into the noſe: the teſticles are concealed in the abdomen, and the mammæ are ſituated by the ſides of the vulva. Their anterior extremities are ſo ſhort, and the bones and articulations are ſo much concealed under the ſkin, that they repreſent oars, and are only fitted for ſwimming.

Among the mammiferous quadrupeds, there are a great number which have the toes ſo much enveloped by horn, that their feet can only ſerve to ſupport them in progreſſion.

Theſe are all herbivorous, and their teeth are therefore fitted for bruiſing vegetables. They have very long inteſtines, and large bellies. They form three families.

That of the *ruminantia*, which is the moſt numerous, is cloven-footed. The dentés molares, which are wanting in the upper jaw, are ſupplied by round callous eminences. The ſtomach is divided into four cavities; and the aliments which have paſſed through the two firſt, return to the mouth to be maſticated a ſecond time. The inteſtinal canal is exceedingly long, as is alſo the cæcum. Their fat becomes hard and brittle when it has cooled. Their mammæ are ſituated between the thighs. The penis of the male has no internal bone.

That of the *pachydermata* has more than two toes to the foot; inciſive teeth in both jaws; and frequently enormous canine teeth. The ſtomach in theſe animals has ſome contractions, but it is not divided into ſeveral cavities, and they do not ruminate. Their mammæ extend under the belly when they are numerous.

That of the *ſolipeda* is diſtinguiſhed by having only one apparent toe to each foot. They have inciſive teeth in both jaws; a ſimple and ſmall ſtomach, but very large inteſtines, and particularly an enormous cæcum. Their mammæ are ſituated in the groin, like thoſe of ruminating animals. The cetaceous and hoofed animals have, in general, the liver very little divided.

The mammalia, that have diſtinct toes, covered merely with nails or claws at their extremities, form likewiſe ſeveral families, to which we may aſſign common characters deduced from the entire of their organization.

The leaſt numerous, and the leaſt perfect, is that of the *tardigrada*. Though their toes are not covered with horn, they are united by the ſkin, and cannot be moved ſeparately; they are beſides few in number. The dentes inciſores are wanting in both jaws. The ſtomach is quadruple, as in the ruminantia; but the aliments do not return to the mouth. The mammæ are placed on the breaſt. The anterior legs are long, which conſiderably embarraſſes the motion of the animal in walking.

The *edentata* is a ſecond family, which reſembles the former in the little freedom of the toes, and the want of the inciſores. Several ſpecies are indeed entirely deſtitute of teeth: they single they have a ſimple ſtomach; their mammæ are ſituated under the abdomen; they have all a ſnout more or leſs prolonged; and moſt of them have a defenſive covering, conſiſting of ſcales, &c.

The *rodentia* form a third family of mammiferous animals with claws, characteriſed by two long inciſive teeth, at the end of each jaw, which are ſucceeded by an interval without any canine teeth. This organization compels them to gnaw their aliments, or to reduce them to very ſmall fragments, inſtead of cutting them in mouthfuls, as is done by thoſe animals that have a number of ſhort inciſive teeth. The rodentia feed on vegetable or animal ſubſtances, or on them both mixed, according as their molares have flat crowns, or ſharp points, or are merely elevated into blunt tubercles. Their inteſtines are long; their ſtomach ſimple; and they have almoſt always a large cæcum. Their poſterior feet are longer than the anterior, which gives to their motion the appearance of leaping. Sometimes the difference in the length is ſo great, that theſe animals cannot employ the fore feet in walking.

The *ſarcophaga*, which do not differ much from the rodentia in the diſpoſition of their claws, have, however, a more complete ſet of teeth: their inciſors are ſhort and ſtrong, their canine teeth ſtrong and pointed, and their molares ſharp and denticulated. Theſe three kinds of teeth form altogether an uninterrupted ſeries. The alimentary canal is ſhort; the ſtomach and the cæcum ſmall. The latter, indeed, does not exiſt in thoſe ſarcophaga which walk wholly on the ſole of the foot, or that have long bodies ſupported by very ſhort feet. In all of them the belly is more or leſs ſlender, on account of the ſmallneſs of their inteſtines.

Theſe two families, the rodentia and ſarcophaga, have their mammæ ſituated under the belly, and the urethra partly enveloped in a bone. All thoſe quadrupeds we mention have the penis encloſed in a ſheath attached to the abdomen.

The *amphibious mammalia* form a ſmall family, ſimilar in many reſpects to the ſarcophaga; but their members are ſo ſhort that they can ſcarcely ſerve for any other purpoſe than that of ſwimming.

The *bats* likewiſe form another little family, ſomewhat ſimilar to the ſarcophaga in their teeth and inteſtines; but the intervals between the toes, (which are very long,) and alſo thoſe between their members, are occupied by a fine ſkin. This organization enables them to fly. They have no cæcum. Their mammæ is ſituated on the breaſt, and the penis is pendent.

The two laſt circumſtances exiſt in the *quadrumana*, which, of all the mammiferous animals, are thoſe that moſt reſemble man. Like him they have the thumb ſeparate from the fingers, to which it is capable of being oppoſed when it is requiſite to perform any delicate operation. The feet are ſimilarly formed; the great toe is ſhorter than the others, which are long, like the fingers. The teeth reſemble thoſe of man, except that the dentes canini are longer than the others. The alimentary canal, except in ſome ſpecies, is compoſed, as in man, of a ſimple ſtomach, of ſmall and great inteſtines, and of a thick and ſhort cæcum. The liver of animals that have claws, is divided into more numerous lobes than that of man and hoofed animals.

The claſs of birds do not preſent as many anatomical characters as that of mammalia, to enable us to diſtinguiſh into families the different ſpecies that compoſe it. The form of their feet does not, as in quadrupeds, determine the nature of their food, becauſe the power of flying, of ſwimming, or of diving, affords them other means of purſuing their prey.

Birds of prey, properly ſo called, are not the only birds that live on fleſh. They are diſtinguiſhed by their beak and hooked claws. Their ſtomach is membranous; their cæca are very ſhort; their inferior larynx has only one muſcle.

The *piſcivorous birds* of the family of river-birds, ſuch as the *herons*, &c. have a large membranous ſtomach, and one very ſhort cæcum.

The other *piſcivorous birds* of the family of ſwimming-birds, ſuch as the *cormorant*, *pelican*,

&c. of the paſſerine family, as the *king-fiſher*, have likewiſe a membranous ſtomach. This organ is alſo of a ſimilar ſtructure in the birds that live on worms, ſuch as the *wood-pecker*, &c. but it is very muſcular in moſt other birds, and particularly ſo in thoſe that live entirely on grain.

The other internal parts do not furniſh very marked characters; or it may rather be ſaid, that as theſe parts do not exerciſe a powerful influence on the whole, they have but few variations in their ſtructure.

Confining ourſelves, therefore, to the conſiderations of the organs of motion, we find, beſides the family of the birds of prey mentioned above, that of the ſwimming or *anſer~~es~~*ine*-birds*, which have ſhort palmated feet, a cloſe plumage, beſmeared with an oily liquor, and which live almoſt conſtantly in water: the families of the *wading-birds*, or *grallæ*, which have long feet, naked legs, long necks, and bills, and which wade among the water, by the banks of rivers, ſtreams and marſhes: that of the *gallinaceous birds*, which have ſhort feet, fly heavy, or do not fly at all, have ſhort arched bills, and which reſide on the earth, where they live upon grain. The laſt have a large ingluvies, a ſtrong fleſhy gizzard, and the inteſtines, particularly the two cæca, very long: their inferior larynx has no particular muſcle. The family of the *climbers*, or *ſcanſores*, are diſtinguiſhed by two toes placed before and two behind, and by the power which this ſtructure gives them of climbing in all directions; ſome of them, as the *wood-peckers*, have a membranous ſtomach, and no cæcum; others, as the *parrots*, have a muſcular ſtomach, and alſo want the cæcum: finally, there are others which have cæca, and a gizzard, as *cuckoos*, &c. The former live on inſects, the latter on fruits.

The numerous genera of birds which cannot be included in the preceding families, are known, by naturaliſts, under the general denominations of *ſparrows* and *rollers*. It is difficult to aſſign to them any common characters: we may, however, reduce them into tribes of an inferior order, which form very natural diviſions; ſuch are, that of the ſmall birds with delicate bills, which live upon inſects, and leave our climates in winter; that of the little birds with large bills, which live on grain, and injure cultivated fields; that of the birds with long and thick beaks, which live on fruits, grain, and animal ſubſtances, and ſome of which even do not diſdain carrion; &c.

The reptiles may be reduced to a regular diviſion much more eaſily than birds: thoſe which have no feet, as the ſerpents, have the body of a long form, to which that of the viſcera correſponds. Their jaws are both moveable, and are capable of ſo great a ſeparation that the animal ſwallows bodies thicker than itſelf, their cartilaginous and forked tongue has a kind of ſheath, from which it is thrown out, and into which it returns, at the animal's pleaſure. The ſtomach is long and membranous. The alimentary canal is ſhort, and has no cæca. The male has two penes, covered with prickly eminences; the female produces eggs, which are ſometimes hatched in the oviduct.

There are very few reptiles with two feet. Among thoſe that have four feet we ought to diſtinguiſh the tortoiſes, which are partly covered with an oſſeous ſhell, and the lizards, which have ſcales, from the frogs and ſalamanders, which have naked ſkins; becauſe the two firſt kinds lay eggs completely fecundated, with a hard ſhell from which their young come forth under the form they always retain; while the two latter lay ſoft eggs, that ſwell after they are depoſited in water, and produce young, which have a form ſimilar to that of fiſhes,—live like fiſhes in water, and reſpire during a conſiderable time by branchiæ, after which they aſſume the form of their parents.

The fiſhes are divided into two principal families, which are very different as to number. The ſmaller, that of the *Chondropterygii*, reſembles ſome reptiles, particularly in the female organs of generation, which conſiſt in two very long oviducts, terminating at the one end in the ovaries, and at the other in a common uterus.

The ſecond family comprehends all the other kinds of fiſh; but with reſpect to them the anatomiſt can form no diſtinction except what is founded on the ſtructure of the bones, and which divides them into *cartilaginous fiſhes* and *oſſeous fiſhes*. The other characters employed by naturaliſts, are relative to the poſition of the fins, and to ſome leſs important varieties, which are more or leſs apparent in the parts that cover the branchiæ externally; but which do not indicate any thing uniform in the internal organization of the animal.

The claſs of *moluſca* is diſtinguiſhed into three families, which appear to form very natural diviſions. The firſt includes the animals called *cephalopoda*, becauſe they have their feet on the head. Their body has the form of a ſack. They have three hearts. They reſpire in water by branchiæ. Their mouth is placed in the centre of their feet, and reſembles a beak. The head is alſo diſtinguiſhed by very large eyes, and has the ears placed internally. The ſtomach is muſcular, like a gizzard. The liver is very voluminous. A particular gland ſecretes a black liquor, which they throw out, and which darkens the water around them whenever they wiſh to conceal themſelves. Their ſexes are ſeparate.

The *gaſteropoda*, which are ſo called becauſe they crawl on their bellies from the ſecond order. —in theſe animals the head is moveable, and frequently provided with tentacula. The heart is ſingle. Their organs of reſpiration vary in their form and poſition, according to the genera. The liver is very voluminous. The two ſexes are united in the ſame individual. They cannot, however, fecundate themſelves, but for that purpoſe require a reciprocal copulation. A conſiderable number are provided with ſhells, but they are never bivalvular.

The bivalves are found in the third order, that of *the acephala.* There are alſo ſome of theſe animals which crawl on the belly. The head is enveloped in a fleſhy involucrum or hood; the ſhells are double; properly ſpeaking they have no head, but only a mouth. The heart is ſingle, and ſituated towards the back. The branchiæ are laminæ, or leaves, placed on each ſide within the hood. They do not copulate; ſeveral of them even experience no change of place, but remain perpetually attached to rocks.

The *worms,* which we place next to the moluſca, are the animals that formerly bore that name, in which we obſerve a vaſcular ſyſtem, and a ſpinal marrow, knotted like that of inſects; they form two families. Thoſe which have branchiæ appearing externally, and thoſe which have none. The latter appear to have their ſexes united like the gaſteropoda.

The *cruſtacea* furniſh only two diviſions, which correſpond with two genera eſtabliſhed by Linnæus, under the names of cancer and monoculus, The *inſects* divide at firſt into two great branches. The firſt comprehends thoſe which cannot maſticate ſolid bodies, and which live only by ſucking vegetable or animal juices; ſome, as the *hemiptera* or *ryngota*, only undergo a ſemi-metamorphoſis; that is to ſay, the larvæ differ from the perfect inſects only with reſpect to the wings, which they want. Theſe inſects have a ſharp roſtrum, containing ſeveral briſtles, which are capable of cutting the ſkin; the ſtomach is ſingle and muſcular, the inteſtines are ſhort.

Others, (as the *diptera* or *antliata*,) undergo a complete metamorphoſis. Their larva reſembles a worm; their nympha is immoveable. The perfect inſect has only two wings; its ſucking tube is armed with briſtles or lancets; ſome of them have beſides a fleſhy proboſcis with two lips. The tracheæ terminate in air-bags, which frequently occupy the greater part of the abdomen.

A third order, that of the butterflies, (*lepidoptera* or *gloſſata*,) alſo undergoes a complete metamorphoſis. Their larva (the caterpillar) is provided with long jaws; with a ſhort, ſtraight, thick, and very muſcular inteſtinal canal; with very long hepatic veſſels, and with veſſels fitted for producing ſilk. The perfect inſect has very ſmall convoluted inteſtines, one inflated ſtomach, and tracheæ, ſupplied with veſicles, &c. the mouth is a double ſpiral ſyphon.

Finally, there are a ſmall number of inſects of this claſs, that are never metamorphoſed, and never have wings.

The other branch, that of the inſects which are provided with jaws, and which feed upon ſolid ſubſtances, likewiſe includes ſeveral orders.

The *coleoptera* have two wings, which fold under two caſes; the metamorphoſis of this kind of inſects is complete; their larva has ſix ſhort feet, a vermiform body, a ſcaly head, ſtrong jaws, ſhort and thick inteſtines, four long hepatic veſſels, tubular tracheæ, &c. The perfect inſect has four jaws. The feelers are attached to the two inferior jaws, which are partly covered by the lower lip; the inteſtinal canal is frequently much longer than in the *larva* ſtate; the parts of generation occupy the greater part of the abdomen.

This order might itſelf be ſubdivided into families, ſeveral of which have very diſtinct anatomical characters. For example, the *ſcarabæi*, the larva of which have an alimentary canal, divided into a ſtomach, a ſmall inteſtine, a colon and rectum; the colon is thick and ſwoln, the tracheæ are tubular. The perfect inſect has long ſlender inteſtines, without any ſenſible dilatations; its tracheæ are veſicular, its teſticles very numerous.—Next, the *carnivora*, which have ſix feelers; their inteſtinal canal, in the perfect ſtate, is very ſhort; they have two ſtomachs, the ſecond of which is villous on the external ſurface, &c.

The ſecond order of inſects with jaws is that of the *orthoptera* or *ulonata*. The caſes of their wings are ſoft; they fold them under, in the manner of a fan; their jaws are covered by a peculiar part called the helmet (galea); their ſtomach is at leaſt quadruple, and not unfrequently they have more than four ſtomachs; their hepatic veſſels are extremely numerous and intricate. Thoſe inſects only undergo a ſemi-metamorphoſis; the rudiments of the parts of generation are often obſerved in their larvæ.

The third of theſe orders include the *neuroptera*; the inſects of this kind have four membranous articulated wings. Conſidered in the whole, they have not many common anatomical characters; but there are ſome remarkable families which have an uniform ſtructure; as (1) the *libellulæ* or *odonata*, the larvæ of which catch their prey at a diſtance, by a ſudden extenſion of the lower lip; the alimentary canal is ſhort, ſtraight, and a little dilated at the part of the ſtomach. The rectum is the principal organ of reſpiration, as almoſt all the tracheæ ariſe from it. The internal parts of the perfect inſect are ſmaller than thoſe of the larva, and its tracheæ are veſicular.—(2) The *agnatha*: the larva of this family exiſts a long time previouſly to its metamorphoſis, but the perfect inſect periſhes at the end of a few hours. It exhibits only the veſtiges of the jaws, &c.

The fourth order is that of the *hymenoptera* or *piezata*: this order has four wings, which are veinous, but not reticulated. Theſe inſects reſemble the coleoptera in the diſpoſition of their jaws, and the complete metamorphoſis they undergo.

The inteſtinal canal is very large in the larva; but it is much leſs in the perfect ſtate, in which it diſplays only one or two ſlight dilatations. The hymenoptera includes the inſects moſt remarkable for induſtry, and particularly the bees.

Finally, there are a ſmall number of inſects with jaws, and deſtitute of wings; on the anatomy of which no general obſervation occurs.

The *zoophyta* are very naturally divided according to the ſimplicity of their organization. The firſt order, the *echinodermata*, includes the zoophytes, that are provided with feet, teeth, a diſtinct ſtomach and inteſtinal canal, and with evident reſpiratory organs; theſe are the *ſea-urchins*, the *ſtar-fiſh*, &c. A ſecond order may be formed conſiſting of thoſe that have their digeſtive or reſpiratory organs very diſtinct, but are deſtitute of teeth; theſe are, the *meduſæ*, the *actiniæ*, &c.

Finally, the *polyps*, whether we conſider thoſe that are naked, or thoſe that have calcareous coverings called corals, ſeem to conſiſt only of a gelatinous ſack, the aperture of which is ſurrounded with ſome tentacula. They are placed in the loweſt rank of animal life.

N. B. The tables connected with this work contain a recapitulation of this chapter, and an enumeration of all the genera that enter into the different diviſions and ſub-diviſions of which we have treated.

LECTURE SECOND.

OF THE ORGANS OF MOTION IN GENERAL.

WE propoſe to employ the firſt part of this Courſe in deſcribing the organs of motion, that is to ſay, the bones and the muſcles; but before we proceed to treat of each bone and muſcle in particular, we ſhall examine the mechanical ſtructure, the chemical nature, and the organic functions of the oſſeous and muſcular ſyſtems in general, and the variations which occur under those three heads, in the different claſſes of animals.

ARTICLE I.

Of the Muſcular Fibre.

ANY portion of muſcle preſents, on the firſt view, filaments ſometimes red, ſometimes white, according to the kind of animal from which it is taken. Theſe filaments, which are generally placed parallel and cloſe to each other, ſeem to form ſmall faſciculi, or rather large filaments, which, by their union, conſtitute the muſcles. Some intervals are obſerved between the different faſciculi. In the animals that have red blood, and the moluſca, theſe interſtices are filled with a cellular ſubſtance finer than that which ſeparates the muſcles, and leſs compact than that which covers them. The filaments that compoſe each faſciculus, are united by a cellular membrane finer than the former: and when we examine one of theſe filaments in a microſcope, we obſerve that they are divided into ſtill ſmaller filaments, but ſimilar to the firſt, and united in the ſame manner. This diviſion continues as far as we can follow it, and our inſtruments are incapable of ſhewing where it terminates.

The laſt of thoſe filaments, or the moſt delicate fibres we can perceive, do not appear hollow;—we do not obſerve any cavity in them. It ſhould ſeem that they may be regarded as the moſt ſimple collections of the conſtituent particles. In fact, their formation, or, as it might be termed, their cryſtallization, is obvious when the blood congeals. When a muſcle has been freed by boiling, and maceration of its blood, other fluids, and, in general, all the ſubſtances it contains that are foreign to its fibre, it exhibits a white filamentous tiſſue, which is inſoluble even in boiling water, and reſembles, in all its chemical properties, the reſiduum of the craſſamentum of the blood, after all the colouring part has been removed by ablution. This matter, in conſequence of the abundance of azote which enters into its compoſition, poſſeſſes a character of animality perhaps more ſtriking than the other animal ſubſtances. It appears, then, that the elements of fibrous matter are ſo cloſely approximated in the blood, that very little repoſe is ſufficient to make them coagulate: In the ſtate of life, therefore, the muſcles may doubtleſs be regarded as the only organs capable of ſeparating that matter from the maſs of the blood, and appropriating it to themſelves.

The *fibrine* (for this is the name which the chemiſts have given to the ſubſtance we have deſcribed,) is not confined to red blood only; the white fluid, which ſupplies the place of the blood in ſo great a number of animals, also contains it. But it is not found in the craſſamentum of their blood; its filaments merely float in the ſerum*.

As the ſubſtances of which the blood is formed do not contain, at leaſt in herbivorous animals, any thing that reſembles this fibrous matter, and as, even in thoſe that are carnivorous, it appears to be decompoſed by the act of digeſtion, and is manifeſtly neither contained in their blood nor their lymph, it may be concluded that it is reſpiration which ſo changes the compoſition of the blood as to render it capable of engendering the fibrine. This idea is ſupported by the nature of the chemical operations which conſtitute the act of reſpiration, and the effects of that function on the organic ſyſtem. Reſpiration, by removing the hydrogen and carbon from the blood, augments the proportion of its azote; and as it is reſpiration which preſerves the muſcular irritability, it is natural to ſuppoſe that this is performed by increaſing the quantity of the ſubſtance in which that irritability excluſively reſides.

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* This diſcovery has not yet been publiſhed by its author; I ought, therefore, to ſtate that it belongs to Citizen Hombert, of Havre, a very ingenious chemiſt, who has applied himſelf, with much ſucceſs, to the comparative chemiſtry of animal ſubſtances.

But though there is no irritability without fibrine, that property does not ſhew itſelf in the pure fibrine when detached from the organic maſs; it only retains it during life, and while its natural connection with the nerves and blood veſſels, or at leaſt with their moſt minute ramifications, ſubſiſts. In fact, there is no part of the body which may be properly called fleſhy, that is not penetrated, in every direction, by nervous fibres; and though we cannot trace nervous filaments in their diſtribution over each particular fleſhy fibre, the ſenſibility which pervades the whole muſcular ſubſtance, even in its ſmalleſt portions, does not permit us to doubt the exiſtence of this diſtribution.

The animals that have not diſtinct and ſeparate nerves, have no viſible fleſhy fibres, and, as we have already ſhewn, irritability and ſenſibility do not in them appear to belong excluſively to any particular ſyſtem of organs. The exiſtence of veſſels, and a cellular ſubſtance, are neither ſo neceſſary nor ſo general; for the muſcles of inſects, though very diſtinct and very powerful, contain neither the one nor the other. The fibres which compoſe theſe muſcles are ſimply contiguous and parallel, and have no adheſion. As they are only fixed at their extremities, if we cut them at the part by which they are attached, the fibres ſeparate like the threads of a piece of cloth when the woof is unravelled. Cellular ſubſtance is even very uncommon in the muſcles of moluſca, though their veſſels are pretty numerous. In all red-blooded animals, however, the muſcular fibres are ſtrongly united by cellular membranes, and are every-where interlaced by numerous blood-veſſels.

The colouring matter of the blood ſeems to attach itſelf by a kind of preference to the fibrous ſubſtance, as it does to the craſſamentum at its formation, ſince the red colour is more peculiarly proper to muſcular fleſh, though other kinds of organs appear to contain proportionally as much blood. Beſides, the fibre of white-blooded animals is, the colour excepted, exactly ſimilar to that of the red-blooded; the latter exhibits ſeveral ſhades of red: certain claſſes having, in general, the muſcles more pale, as the reptiles and the fiſhes; and the muſcles themſelves have not all the ſame degree of redneſs.

Muſcular irritability is that property which the fleſhy fibre poſſeſſes of ſhortening itſelf by oſcillation, and of contracting itſelf, in conſequence of certain determinate actions external to the fibre itſelf, and in which the mechanical cauſe cannot be diſcovered. This property is very diſtinct from the elaſticity of the fibres, which is common to them, with many other natural bodies; as well as from another faculty, which is common to them, with many other parts of living bodies, by which they tend continually to ſhorten themſelves, and, in fact, always contract when they are at liberty ſo to do. Irritability is not conſtant, but when it exiſts, it produces contraction, notwithſtanding the ordinary obſtacles.

The cauſes which occaſionally excite the irritability of the fibres, may be divided into five orders: volition, external actions operating on the nerves, external actions operating on the fibre itſelf, mixed actions operating on both the nerves and the fibres, and finally, certain diſeaſes and certain violent emotions.

When the body is in a ſtate of health, and awake, the will exerciſes a moſt conſtant and prompt empire over the greater part of the muſcles, which are for that reaſon called voluntary. A ſmall number are not ſubject to the will; theſe produce internally the movements that are neceſſary to life, and which cannot be interrupted; ſuch as the motion of the heart and the inteſtines. It is to be obſerved, however, that ſome of the muſcles which act involuntarily in men and ſeveral animals, obey the will in others: ſuch, for example, is the ſtomach in ruminating animals, the movements of which they can command at pleaſure, in two different directions. The motion of ſome other muſcles appears to be of a mixed nature; we can ſtop their action, but their motion is continued by habit, without our formally willing it, or even without our conſciouſneſs—ſuch are the muſcles of reſpiration.

The muſcles that are abſolutely involuntary, are continually expoſed to the action of an irritating cauſe of an extraneous nature; for the veinous blood which arrives on each diaſtole to the heart, determines that organ to contract itſelf, and the aliments act in a ſimilar manner on the ſtomach. It ſeems, therefore, that the will is not neceſſary to make theſe muſcles act, and that it cannot ſtop their motion. A muſcle laid bare, and expoſed to an irritating cauſe, would contract itſelf, even in the living ſubject, without any participation of the will. It ſhould alſo be remarked, that the nerves of the involuntary muſcles are generally ſmaller than thoſe of the other muſcles. Indeed it was long doubted whether the heart really had any nerves; yet the irritability of the involuntary muſcle is more durable, and more eaſily excited than that of the voluntary kind. This ſeems to prove that irritability is not entirely connected with the largeneſs of the nerves, though, at leaſt, it partly depends on theſe organs.

Indeed, volition, the irritating cauſe which we have at preſent to conſider, acts only through the medium of the nerves; and if a nerve be cut, or a ligature made upon it, the muſcles over which it is diſtributed no longer obey the will. This action of the will may be imitated by concuſſions, punctures, or lacerations, made on the nervous trunks. Theſe operations are immediately followed by convulſions in all the muſcular parts to which the ramifications of the nerves extend, and this takes place even after death. The irritation of the medulla oblongata, after decollation, agitates all the muſcles of the face; and that of the cervical part of the ſpinal marrow, throws the whole body into convulſions.

Violent paſſions may, in a certain degree, be regarded as the acts of the will ſtrongly excited, which, in ſome caſes, has an influence even upon the involuntary muſcles: of this the palpitations of the heart and large veſſels, and the ſuſpenſion even of their motions, are examples.

Theſe actions, however, may be prevented by prudently moderating the exceſs of that ſenſibility which occaſions them. Even in nervous diſeaſes, which appear to have the leaſt connection with the paſſions, at leaſt with thoſe, the influence of which is immediately felt, the will is capable of preventing their acceſs, when the patient is determined to reſiſt it with firmneſs.

The effect of the will on the muſcles is not then immediate; it depends on the action of the nerve on the muſcular fibre, which it is in our power to determine by the means of that incomprehenſible influence which the mind exerciſes over the nervous ſyſtem: but if this connection between the underſtanding and the nerve appears to be beyond the limits of our knowledge, it ſtill ſeems poſſible that we may one day diſcover the nature of the relation that ſubſiſts between the nerve and the fibre, which can only be purely phyſical, or the action of one portion of matter upon another.

The galvanic experiments render it exceedingly probable that this action is performed by an inviſible fluid, of which the nerves are the conductors, and which, under certain circumſtances, changes the nature or quantity of the fibre.

It is well known, that theſe experiments conſiſt in eſtabliſhing, between a muſcle and the trunk of the nerves which extend to it, an external communication with one, or a ſeries of ſubſtances placed cloſe to each other. Metals are not the only means that may be employed in this operation; and, in general, the conductors are not the ſame as thoſe of electricity. Experiments have ſometimes been ſucceſsfully performed, when an interval was left in the ſeries of excitators*: this circumſtance proves the exiſtence of an atmoſphere.

The moment the contact takes place, the muſcle ſuffers violent convulſions. Theſe experiments ſucceed on the living body, on animals recently dead, and even on parts ſeparated from the body, preciſely in the manner of thoſe which Haller accounts for on the principle of irritability. Neither pointed inſtruments nor acrid liquors are neceſſary; and the galvanic experiments even ſucceed when thoſe means have failed.

It is evident that the galvanic convulſions can only be aſcribed to a change in the internal ſtate of the nerves and fibres, towards the production of which both thoſe organs concur. But in the galvanic ſenſations which occur in living bodies, when an excitatory communcation is eſtabliſhed between two branches of nerves, we have a proof that this change may even take place in the nerve alone, whether that change be produced ſimply by tranſmiſſion, or by a chemical decompoſition. The fibre, therefore, may be ſimply paſſive in its contractions; but it ſhould always be recollected, that it is the only part of the body which is ſo conſtituted as

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* The name given to the foreign ſubſtances that act on the muſcles, in the galvanic experiments.

to be capable of receiving this kind of impreſſion from the nerves; for it is well known that the nerves are diſtributed over a number of other parts, which poſſeſs no appearance of irritability.

The influence and joint operation of the nerves are, therefore, clearly demonſtrated in four of the irritating cauſes we have mentioned above; that is to ſay, in volition, in the paſſions and nervous diſeaſes, in mechanical actions directed immediately on the nerve, and in galvaniſm, in which the nerve and the fibre are both acted upon at once.

A fifth order of irritating cauſes remains to be examined—thoſe which operate when immediately applied to the fibre, and which act on the fibre only; that is to ſay, all external ſtimuli, ſuch as pointed inſtruments, &c. But as every portion of muſcular fleſh is penetrated by nervous ſubſtance, it is difficult to ſuppoſe that the nerve may not be affected upon touching the fibre; and it appears probable that the contractions which the latter in this caſe experiences, proceed, as in all the preceding caſes, from the influence of the nerve, in conſequence of the ſtate of its internal fluid being changed by the action of the ſtimulus. A muſcle taken from the body, doubtleſs, preſerves a ſufficient portion of the nervous ſubſtance to render it, for ſome time, irritable; and the muſcles over which volition has loſt its empire in conſequence of a paralyſis, or the ligature of a nerve, may, notwithſtanding, obey external ſtimuli, becauſe the nerve, in that ſtate, ſtill retains the faculty of producing, or tranſmitting the fluid, on which the contraction of the fibre depends; for as we are totally ignorant of the manner in which the will acts on nerves, we cannot pretend to ſay that the interruption of its action muſt neceſſarily be accompanied by that which the nerves themſelves exerciſe on the muſcle.

It ſhould be further obſerved, that every thing proves that this action of the nerve on the fibre does not require ſenſation, and conſciouſneſs. This is obvious, from the example of paralytic members, which not only contract when ſtimuli are applied, but which ſometimes even obey the will; from that of the viſcera, which are continually performing motions within us, of which we are inſenſible; and finally, by the experiments made on portions of animals; for it appears repugnant to the notions we entertain of *ſelf*, and of the unity of our being, to admit the poſſeſſion of ſenſation to thoſe fragments, though it muſt be confeſſed, that there are ſeveral examples of animals, in each part of which there appears to be formed, at the very moment of their diviſion, a particular centre of ſenſation and volition. This difference between irritability, even that kind which is voluntary, and ſenſibility properly ſo called, is ſtill more eaſily proved by the experiments of Arnemann, from which it appears, that a nerve cut, and afterwards united, has recovered the firſt of thoſe faculties, but not the other. The nerves and their functions are only dependent on the mind, while different ramifications communicate with the general trunk of the nerves; but they appear capable of exercising, through the medium of their own ſubſtance, that part of their functions which is purely phyſical: and if thoſe functions depend upon a fluid, it may be ſuppoſed that it is capable of ariſing from all the points of the medullary ſubſtance. This is the opinion of Reil, and it is ſupported by experiments, long before made, by Stenon and others, which ſhew that a ligature on an artery paralizes the muſcle through which it paſſes.

The whole of what we have ſtated above applies equally well to all the different claſſes of animals. They are all irritable, and all thoſe that have nerves and muſcles apparent are ſubject to galvaniſm. M. Humbolt has adopted an ingenious method of diſtinguiſhing the nerves from the arteries, or other parts, in the ſmalleſt animals. He uſes two needles, one gold, and another ſilver: A point of one is applied to the muſcles, and a point of the other to the filament, the nature of which he wiſhes to diſcover, while the other extremities of theſe inſtruments are brought in contact. If the filament be a nerve, contractions immediately take place in the muſcular fibre.

When it has once been diſcovered that the concurrence of the nerve is neceſſary to produce the contractions of the fibre, and that the latter is the only part over which the former poſſeſſes this influence, it remains to be inquired by what agent, by what medium, the nerve produces this effect upon the fleſhy fibre. The principal difficulty which occurs in this queſtion, is the conſideration of the prodigious force with which the muſcles contract, and the great weights they are capable of raiſing in a living ſtate, while immediately after death they are torn aſunder by weights infinitely ſmaller. This induces us to believe, that in the moment of action the particles that compoſe the fibre, not only approach towards each other longitudinally, but that their coheſion, or the tenacity of the fibre, becomes inſtantaneouſly much greater, without which the tendency to ſhorten would not prevent its rupture. Now, were it to be imagined that the texture of the fibres was ſuch that the acceſſion of a fluid or a vapour might give them this tendency, a ſuppoſition which at leaſt appears very difficult, it muſt ſtill be admitted, that nothing but a ſudden change in their chemical compoſition could be capable of augmenting ſo promptly, and ſo powerfully, their coheſion. We are already acquainted with the prodigious force, with which the particles of ſome bodies tend to aſſume a new ſituation whenever their chemical compoſition is ſomewhat changed. The beſt known example of this kind, is that which is furniſhed by freezing water. The loſs of a little caloric diſpoſes its molecules to condenſe into acute ſolids, and they aſſume this form with ſo much force that they burſt the ſides of very ſtrong veſſels. The living and contracted fibre is not therefore, ſtrictly ſpeaking, the ſame body, nor compoſed of the ſame chemical materials as the relaxed fibre; and this change is produced through the medium of the nerve by the different irritating cauſes. Is it by loſing or abandoning to the nerve ſome of its elements, or is it by receiving from the nerve ſome new principle, that the fibre thus changes its compoſition? for we muſt adopt one of theſe alternatives. Farther, what is this element which paſſes from the one to the other?—Does it exiſt completely formed in one organ, and is it ſimply transfuſed into the other?—Is it formed by compoſition at the moment of irritation?—or laſtly, does it develope itſelf by decompoſition? Theſe are the queſtions neceſſary to be diſcuſſed.—The new galvanic experiments, and thoſe of an older date, improperly called magnetic, joined to the diſcoveries of modern chemiſtry, and purſued with that delicacy now introduced into the ſtudy of nature, permit us to hope for their ſolution. But men cannot be induced to give themſelves up to thoſe inquiries, if they are habituated to refer every effect to a particular and occult cauſe.

Article II.

Of the Subſtance of the Bones, and the hard Parts which ſupply their Place.

The bones of animals that have red blood differ entirely in their ſtructure and in the manner of their growth from thoſe parts which ſupply their place in other animals. It is therefore neceſſary that they ſhould be ſeparately treated.

The ſubſtance of the bones, conſidered abſtractedly from the marrow and other foreign bodies, which cannot be completely removed, yields, upon analyſis, a variable quantity of animal jelly, or gluten, ſoluble in boiling water, congealable by cold, alterable by fire and putrefaction; and an earthy matter, ſoluble in acids, which has been diſcovered to conſiſt of a combination of lime and phoſphoric acid, or a phoſpat of lime.

The quantity of calcarious phoſphat increaſes in the bones with age; the gelatinous ſubſtance, on the contrary, is moſt abundant in proportion as we examine it near to the epoch of birth. In the early periods of geſtation, the bones of the fœtus conſiſt merely of cartilage, or indurated jelly; for cartilages reſolve almoſt entirely into jelly when ſubjected to the action of boiling water. In the very young embryo there is no ſuch thing as real cartilage; in its ſtead, we find a ſubſtance which has all the appearance, and even the ſemi-fluidity of ordinary jelly, but which has already aſſumed a certain ſhape, and is covered by a membrane, which afterwards becomes the perioſteum. In the firſt ſtage of oſſification, the flat bones have the appearance of ſimple membranes; thoſe which are to move on each other, exhibit viſible articulations, though the perioſteum paſs from the one to the other, and envelopes the whole in one common ſheath; but thoſe which join only by ſutures, as the bones of the cranium, for example, form a continued whole, in which nothing indicates that thoſe ſutures will one day exiſt.

The phoſphat of lime, which gives conſiſtence and opacity to the bones, is depoſited in this gelatinous baſis: but it is not depoſited in an uniform manner; nor do the two ſubſtances unite in ſuch a manner as to form a homogeneous whole.

In oſſification, we firſt obſerve fibres or lamellæ developing themſelves ſeparately; theſe are ſucceeded by new fibres or lamellæ, which ſerve to unite them, and which are extended in every direction.

The ſurface of the bones is moſt generally formed of cloſe and compact fibres, more or leſs regular; that is to ſay, of fibres which diverge as radii in flat bones, and are parallel in long bones. Theſe fibres proceed from certain centres, which are called points of oſſification; each long bone has uſually three points of this kind, one towards its middle, which ſurrounds it as a ring, and the fibres of which extend in a direction parallel to the axis: and another principal point at each extremity of the bone, accompanied ſometimes with ſeveral ſmaller points. When the three oſſeous pieces, formed by the ſucceſſive extenſion of theſe three points of oſſification, have even approached ſo cloſely as to be within contact of each other, they remain for ſome time unconſolidated, and there appears between them a quantity of matter purely gelatinous, capable of being deſtroyed by boiling water, or by maceration. The extremities, while ſeparated, are called *epiphyſes*, in contradiſtinction to the body of the bone which is denominated *diaphyſis*. In the flat bones the centres of oſſification may be compared to ſuns, of which the oſſeous fibres are the rays, rendered viſible in the ſemi-tranſparent cartilage by their opaque whiteneſs. In the round bones theſe centres of oſſification have the appearance of grains, or nuclei. In the very angular bones they aſſume a variety of poſitions and forms.

When the fibres of one centre have advanced ſo far as to come every-where in contact with thoſe which are next them, the bones are then only ſeparated by ſutures, which may afterwards be more or leſs promptly effaced. Some of thoſe fibres turn aſide to join others on the right and left, and thus produce the appearance of lattice-work. New ſtrata are alſo placed above or below the former, and thus the texture of the bones aſſume a lamellous aſpect.

We are accuſtomed to regard as ſingle bones; all thoſe in which the different parts oſſify and unite in youth; as the vertebræ, os occipitis, os frontis, &c. while we conſider thoſe that do not form a union with the neighbouring bones until an advanced period of life as diſtinct bones. Thus the frontal bone, which ſometimes remains ſeparate from the two parietals to a very old age, is regarded as a diſtinct bone; but at the ſame time it is alſo regarded as a ſimple bone, though the two parts of which it is always compoſed, in infancy, frequently remain ſeparate until the age of thirty or forty.

While the bones by the ſucceſſive accumulation of calcarious phoſphat, attain a certain conſiſtency in their ſurface, they alſo receive inwardly laminæ and fibres from the ſame ſubſtance; but which in general do not approximate ſo much as thoſe of the former. The internal laminæ are placed irregularly, like thoſe of the cellular membrane; ſo that generally conſidered, they preſent a real cellular ſtructure, indurated by the acceſſion of earthy matter. In proportion as this ſpongy texture acquires conſiſtency, the gelatinous ſubſtance, which at firſt fills up the whole maſs of the bone, ſeems to diſappear, and to concentrate itſelf in the parts that are oſſified. By this means cavernous interſtices are formed, which are gradually occupied by an unctuous medullary ſubſtance. This is always the ſtate of the flat bones, in which this ſpongy part imbued with marrow, is included between two compact ſurfaces, and is called *diplöe.* In the long bones, however, a conſiderable cavity is formed at the middle of the body of the bones: this cavity being extended towards both extremities, to the excluſion of the ſpongy ſubſtance, the bone at laſt becomes a real tube. In this caſe, the extremities only are occupied by an oſſeous, ſpongy cancelli, while all the middle parts are filled up with a kind of cylinder of marrow, incloſed in a very fine membrane, and provided with numerous veſſels and nerves, which penetrate to it through holes formed in the compact ſubſtance of the bones.

Oſſification, whether we conſider it in each kind of animal, or in the different bones of the ſame animal, does not take place with an equal rapidity. In man, and all other mammalia, we obſerve that the bones of the internal ear are not only firſt oſſified; but that they ſurpaſs all others in denſity, and in the quantity of calcarious phoſphat they contain. The bone of the cavity of the tympanum, in the cetacea, and particularly in the whale and the cachalot, is ſuperior in denſity and hardneſs to marble. Its ſection appears equally homogeneous, and exhibits no veſtige either of fibres, cancelli, or veſſels. On the contrary, there are other bones that are very ſlow in acquiring the conſiſtency they ultimately poſſeſs. The epiphyſes, for example, do not oſſify until long after the bodies of the bones to which they belong. Finally, there are ſome cartilages which, in certain claſſes of animals, never admit a quantity of calcarious phoſphat ſufficient to render them completely oſſeous: ſuch are the cartilages of the ribs, and the larynx. It is certain, then, notwithſtanding the general prediſpoſition of the gelatinous parts to receive calcarious matter, (as appears from the example of tendons, and ſeveral white parts, oſſifying with more facility than others,) and though there is no bone which did not formerly exiſt in the ſtate of a cartilage, that there are ſeveral cartilages which are never converted into bones.

The ſame differences which exiſt in this reſpect between the ſeveral bones of the ſame ſpecies, are alſo found to ſubſiſt between ſpecies and ſpecies, on the compariſon of the whole ſkeleton.

We not only find that the bones of an animal are ſlow in arriving at the degree of hardneſs which belongs to them, in proportion to the period of the growth of the animal; but we farther know, that there are ſome animals in which oſſification is never complete, and whoſe ſkeletons are always cartilaginous. This is the caſe with the *ſharks*, *rays*, *ſturgeons*, and all thoſe fiſh which are on that account called cartilaginous, or *Chondropterygii;* and though the bones of other fiſhes, and of reptiles and ſerpents, attain a greater degree of hardneſs, they ſtill however preſerve much more flexibility, and retain a far greater proportion of the gelatinous ſubſtance, than the bones of animals that have warm blood. Theſe animals therefore grow during the whole courſe of their exiſtence: for it is the cartilage only that grows; and when once the bones have attained their proper degree of hardneſs, their dimenſions do not alter. The animal then can only increaſe in thickneſs. At this epoch the animal œconomy commences a retrograde progreſs, and the firſt ſteps are made towards old age and decrepitude. Independent of the rapidity of oſſification, and the proportions which the conſtituent parts of bones bear to one another, animals differ among themſelves, with reſpect to the texture of the bones, and the cavities of various kinds formed within them. In man, the internal texture of the bones is very fine. The laminæ of their ſpongy ſubſtance are ſmall and cloſe, and where this texture is moſt unlike lattice-work, it exhibits long and delicate fibres. In quadrupeds, the texture of the bones is in general coarſer: in the cetacea it is more looſe; their cells are larger, and the laminæ which form them much broader: it is eaſy to diſtinguiſh their external fibres, which in the jaws and ribs of whales, and cachalots, become, by maceration, as diſtinct as thoſe of half-rotten wood. With reſpect to ſize, however, they bear no proportion to the magnitude of the animal to which they belong; for the dimenſions of the bony fibre, as

well

well as thoſe of the muſcular, appear to depend more upon a chemical compoſition than upon any other circumſtances.

The bones of birds are of a ſlender, firm, and elaſtic nature, and ſeem formed of laminæ ſoldered one upon the other. The bones of reptiles and fiſhes are in general more homogeneous. The calcarious matter ſeems more uniformly diſtributed in the gelatinous. This obſervation becomes more ſtriking as we approach the cartilaginous fiſhes, in which the gelatinous ſubſtance completely overcomes, and appears to conceal the calcarious phoſphat.

Several animals have no large medullary cavities, even in their long bones. We find none in the *cetacea* and *ſeals*. Caldeſi long ſince remarked the ſame thing with regard to the *tortoiſe;* and I have made the like obſervation myſelf. The *crocodile*, however, has theſe cavities very diſtinct.

In ſome bones we find other cavities, called *ſinuses*, which contain no marrow. They all communicate more or leſs directly with the exterior of the body. Man has ſinuſes in the os frontis, the os ſphenoides, and the oſſa maxillaria, which communicate with the naſal cavity.

In ſeveral mammiferous animals theſe ſinuſes extend much farther backward, and penetrate through a great part of the body of the cranium. In the *hog* they proceed as far as the occiput. It is they that ſwell ſo ſingularly the cranium of the *elephant*. They even penetrate into the heart of the bones of the horns of *oxen, goats* and *ſheep*. The *gazells* are the only animals with hollow horns that have the nucleus of their horns ſolid or ſpongy without any large cavity.

There are other ſinuſes in the temporal bone which communicate with the cavity of the tympanum. Theſe are particularly extenſive in birds, and in them occupy as much ſpace as the naſal ſinuſes do in quadrupeds. They produce the ſame effect on the cranium of the *owl* as the other kind of ſinuſes have upon that of the elephant.

Birds have, in this reſpect, a very particular ſtructure: their bones, almoſt without any exception, are hollow internally; but their cavities contain only air, and never marrow. Theſe are real ſinuſes in their kind, which, inſtead of being confined to the head, as in quadrupeds, extend throughout the whole ſkeleton, and have a direct communication with the lungs; the air which is puſhed into the trachea arteria, eſcaping and returning reciprocally by a hole in ſome one of the bones. This organization unites in their bones that levity and ſtrength which is requiſite for the kind of motion which has been aſſigned to them, and, like all the reſt of their ſtructure, tends to ſeparate them from the cold blooded animals, the cavities in the bones of which are either very few or inconſiderable.

The *perioſteum* is a ſtrong white membrane, which adheres to the whole ſuperficies of the bones, except at their articulations. It is called *perichondrium* when it covers cartilages only. This membrane has numerous veſſels; and through it thoſe paſs which convey blood to the cartilages and bones. We know that the principle of the gelatinous ſubſtance is contained in the blood, and that it forms a conſiderable portion of the ſerum, or fluid part, which remains liquid on the formation of the craſſamentum. We alſo know that there is phoſphat of lime in the blood, and particularly, that milk, which is the natural food of man, and ſeveral animals, at the period when oſſification is moſt active, contains a great deal of that ſubſtance. It is, therefore, eaſily diſcovered whence the bones derive their nouriſhment; but the manner in which the calcarious phoſphat depoſits itſelf, is by no means ſo obvious: ſome imagine that it tranſudes from the ſides of the arteries; others, that it ſimply paſſes from their open extremities; and finally, others, that the arteries themſelves oſſify. It is perhaps more probable that it combines with the jelly of the cartilage, and that this combination is more particularly effected at the time when the blood is fulleſt of calcarious phoſphat, in conſequence of the kind of nouriſhment which the animal receives, or by the general diſpoſition of the organs, which act in the formation of its blood. We know too well that there are diſeaſes in which the calcarious phoſphat is removed from the bones by more powerful affinities; and that there are others in which its too great abundance injures certain organs, by inducing rigidity, or produces excreſcences more or leſs monſtrous: its diſproportion in the living body is the cauſe of diſorders that are accompanied by much inconvenience and pain.

Among the more remarkable phænomena of *oſteogeny*, or the developement of the ſubſtance of the bones, Comparative Anatomy particularly exhibits the formations of the horns of the deer.

Theſe horns, in their perfect ſtate, are true bones both in their texture and in their elements: their external part is hard, compact, and fibrous; their internal part is ſpongy, but very ſolid. It has no large cells, no medullary cavity, and no ſinuſes. It is ſufficiently well known what their external forms are, whether in different ſpecies, ſuch as the *elk*, the *rein-deer*, the *fallow-deer*, the *ſtag*, the *roe-buck*, &c. or at different ages in the ſame ſpecies. But theſe objects belong to natural hiſtory, properly ſo called. The baſes of the horns adhere to, and form one body with the os frontis, in ſuch a manner that, at certain ages, it is impoſſible, from their internal texture, to determine the limits between them; but the ſkin which covers the forehead does not extend further; a denticulated oſſeous ſubſtance, called the burr, ſurrounds it; there is neither ſkin nor perioſteum on this ſubſtance, nor on the reſt of the horn; on theſe parts are only to be ſeen furrows more or leſs deep, which are the veſtiges of veſſels that were diſtributed along their ſurface when they were ſoft. Theſe hard and naked horns remain only one year on the head of the ſtag; the period of their fall is varied according to the ſpecies; but when it is near, there appears, on ſawing them longitudinally, a reddiſh mark of ſeparation between them and the eminence of the frontal bone which ſupports them. This mark becomes more and more apparent, and the oſſeous particles of that part loſe, at laſt, their adheſion. At that period a very ſlight ſhock frequently makes the horns drop off; two or three days commonly intervening between the fall of the one and that of the other.

The eminence of the frontal bone, at that time, reſembles a bone broken, or ſawed tranſverſely, and its ſpongy texture is laid open. The ſkin of the forehead ſoon covers it; and when the horns are about to ſhoot again, tubercles ariſe, which are, and which remain, covered by a production of the ſame ſkin, until they acquire their perfect ſize. During the whole of that time the tubercles are ſoft and cartilaginous: under the ſkin is a true perioſteum, in which veſſels, ſometimes as thick as the little finger, are diſtributed, and penetrate the maſs of cartilage in every direction. The cartilage oſſifies gradually as other bones; it paſſes through the ſame ſtages as the bones of a fœtus, or of an infant, and finiſhes by becoming a perfect bone. During this time the burr at the baſe of the horn penetrates the indentations through which the veſſels paſs, and alſo developes itſelf. The indentations, by their growth, confine the veſſels, and in the end obſtruct them. Then the ſkin and perioſteum of the horns wither, die, and fall off; and the bones again becoming bare, in a ſhort while drop off, to ſpring up anew, and always more conſiderable in ſize.

The horns of the ſtag are ſubject to diſeaſes exactly ſimilar to thoſe of ordinary bones; thus, in ſome the calcarious matter is extravaſated, and has formed different exoſtoſes; in others, on the contrary, it is found in too ſmall a quantity, and the horns continue porous, light, and without conſiſtence.

Shells are envelopes, formed by a calcarious ſubſtance, of a foliated texture, and almoſt as heavy and hard as marble. Theſe make coverings for a great number of animals of the claſs of moluſca; and every one knows that the variety of their forms, their more or leſs vivid colours, and the brilliancy of their mother of pearl, conſtitute ſome of the fineſt ornaments of the cabinets of virtuoſi. Natural hiſtory ſufficiently explains theſe forms, and their relation with the orders and genera of the animals which inhabit them: at preſent I have only to conſider their texture, their growth, and the manner in which they are united to the reſt of the body.

They are compoſed like bones of a calcarious matter, intimately connected with a gelatinous ſubſtance, and which may be, in like manner, ſeparated by means of acids; but this matter is not diſpoſed in lamina, or in fibres; it is uniformly extended throughout the whole body of the ſhell.

It is only in ſome ſpecies that we find ſtrata eaſily ſeparated, and, as it were, agglutinated to each other like the leaves of paper in the formation of paſteboard. We know, from obſervation, that theſe ſtrata do not all exiſt in young animals; they have only the moſt external, which are, at the ſame time, the ſmalleſt. In proportion as the animal increaſes in age, it forms a new ſtratum on the internal ſurface of the ſhell, which extends beyond the edges of all the preceding ſtrata, ſo that each operation of this kind adds to the ſize of the ſhell, in length, breadth, and thickneſs. Theſe are certain facts; to prove them it is only neceſſary to compare ſome ſhells of the ſame ſpecies that have belonged to individuals of different ages; the feweſt ſtrata will always be found in the ſhells of the young. *Muſcles*, which may be obſerved when they are very young, and even before they quit the matrix of their mother, have, at that period, ſhells conſiſting of one ſtratum only; but the ſhell is not therefore ſoft and gelatinous; it poſſeſſes the ſame firmneſs as the adult ſhell, and its greater fragility is merely owing to its thinneſs.

But are the ſtrata which thus ſucceſſively augment the dimenſions of ſhells, produced by developement, or by a ſimple juxta-poſition? Do the nutritive veſſels depoſit the calcarious juice at different points, or does it only tranſude through the ſkin of the animal, and attach itſelf to the pre-exiſting ſtrata? Theſe are queſtions with reſpect to which phyſiologiſts are not agreed.

The body of the ſnail appears to adhere to its ſhell only where the muſcles are attached; but Reaumur having placed thin pellicles between the body and parts of the ſhell, which he purpoſely broke, theſe fractures were not repaired; but when this, or any other obſtacle, no longer prevented the juices flowing from the ſurface of the ſkin, the injured part was ſpeedily regenerated.

Theſe facts favour the idea of the ſimple juxta-poſition of a tranſuded matter: we obſerve, however, on the other hand, that the oyſter and muſcle adhere to the ſhell not only by their muſcles, but by the whole border of their cloak; beſides, the oyſter has always between the two laſt ſtrata of the convex valve, a conſiderable vacuity, which is filled with a fœtid acrid liquor, and which communicate with the interior of the body by a particular aperture. How is this vacuity produced? and, above all, how is it removed upon the formation of each new ſtratum, if the arterial and abſorbent veſſels do not penetrate into the centre of the ſtrata, to regulate its poſition, and to remove, from time to time, the particles of the ſhell?

Some obſervations ſeem to prove that there are teſtaceous animals, which, at certain periods, caſt their old ſhells entirely off, and acquire new ones; but this re-production may alſo take place by developement, as in the horns of the deer. If the internal ſtrata of thoſe ſhells which are not caſt off, be produced by a developement of this kind, it may be compared to that which forms the internal laminæ of the hollow horns of the ox, ſheep, and other ruminating mammalia, and even to that by which the epidermis is produced in all animals; that is to ſay, there muſt take place a withering, or, as it were, the death of a membrane, which ſeems to preſerve a ſort of organization while it remains unexpoſed to external elements, or while it has not acquired its proper degree of ſolidity.

In this manner, it appears, are produced all the hard parts which may be regarded as the bones of animals that have no vertebræ. In cray fiſh, for example, the calcarious cruſt which, in them, is at once ſkin and ſkeleton, grows no more after it is completely indurated. The animal, however, continues to increaſe in all its ſoft parts; and when theſe become too much confined by the envelope, the latter ſplits and is detached: but a new covering is found below the old one, which is formed while the latter loſes its connection with the body, and as it were dies. The new envelope is at firſt ſoft, ſenſible, and even provided with veſſels: but a quantity of calcarious particles, previouſly accumulated in the ſtomach, is ſoon depoſited in this covering, hardens it, obſtructs the pores and the veſſels, and renders it in every reſpect ſimilar to the ſhell it has replaced.

The induration of the covering of inſects is not completed until they acquire their laſt form, after which they have no longer any occaſion to change their ſkin: but all their ſkins they previouſly caſt, though ſoft, are dead, and already replaced by others, which develope themſelves underneath that which is deſtined to fall off.

All the hard parts therefore of white blooded animals, whatever may be their conſiſtence and chemical nature, ought to be compared with reſpect to the manner of their growth to the epidermis, to nails, and to hollow horns, rather than to real bones. The ſame remark ſhould perhaps be applied to certain external parts of fiſhes, though their ſubſtance is ſtrictly oſſeous. I mean the bucklers of the *ſturgeon* and *cyclopterus*, and the ſpinous tubercles of the *ray*.

Some white blooded animals have alſo hard parts internally; but they are not articulated in ſuch a manner as to form the baſes of moveable members, and their texture differs conſiderably from that of ordinary bones. The moſt remarkable of thoſe hard parts are, the teeth in the ſtomach of the lobſter, the deſcription of which, as well as that of the common teeth, we ſhall poſtpone until we come to treat particularly of digeſtion, and of the bones of cuttle fiſh, and calmars, of which we are now about to give an idea.

The common cuttle fiſh (*ſepia officinalis*), contains in the fleſh of the back an oval ſubſtance, convex before and behind, white, ſolid, friable, and of a calcarious nature. This ſubſtance is not attached to the fleſh, but has the appearance of a foreign body introduced into it. There is no indication of any veſſel or nerve penetrating it, nor is any tendon affixed to it. It is compoſed of thin parallel lamellæ, which are not in immediate contact with each other. The intervals are occupied by an infinite number of ſmall hollow columns ſtanding perpendicular between one lamellæ and another, and arranged in a very regular quincunx.

As the ſuperficies of the lamellæ are plane, and thoſe of the bone itſelf convex, they neceſſarily interſect each other: the points of interſection are marked on the ſurfaces of the bone by regular curvilinear ſtriæ. Theſe bones have a kind of wings which are of a leſs opaque nature, leſs brittle, and have a greater reſemblance to thin elaſtic horn, than the body of the bone.

To this laſt ſubſtance the part called the bone in the *calmars* (*ſepia Loligo*) bear a reſemblance; they are tranſparent, elaſtic, and very brittle; their ſhape is ſometimes that of a leaf, and ſometimes it is ſimilar to a ſword blade. Their connection with the ſoft parts is the ſame as the bone of the cuttle fiſh.

We alſo find a ſmall ſemi-cornuous and ſemi-friable plate in the body of the fleſhy lobe, which covers the branchiæ of the *aplyſia*, and there is even one ſtill ſmaller in the cloak of the *ſlug*.

Every thing tends to convince us that thoſe hard parts which are found within moluſca, grow by ſtrata, like their external envelope, and that they are a kind of internal ſhells.

Two genera, which we place among the zoophytes, but which will perhaps acquire a higher place when their organization ſhall be completely known, *viz.* ſtar fiſh (*aſterias*), and ſea urchins (*echinus*), have a kind of ſkeleton, the nature of which appear very much to reſemble that of the ſhells of the moluſca.

In the *urchins*, this ſkeleton is a ſolid calcarious envelope, frequently very hard. It has a number of little holes through which paſs membranous feet, furniſhed with tubercles and points analogous to the ſubſtance of the ſhell which play freely on theſe tubercles.

In the ſtar fiſh the calarious part forms a ſtalk compoſed of a number of ſmall articulated vertebræ, which extend under the middle of each of the branches of the body, and to which is attached a kind of oſſeous grating, which ſupports the remainder of the envelope of the branch to which it belongs, and which is rendered remarkable, even externally, by its projection, and by the tubercles of different forms that cover the whole of its ſurface.

Their oſſeous ſtalk cannot be regarded as completely external, ſince it is covered outwardly by an epidermis and other ſoft parts. This is perhaps the moſt ſtriking exception to the general rule that white blooded animals have no internal articulated ſkeleton.

The mode of growth of the ſkeleton of the ſtar fiſh has not yet been ſufficiently inveſtigated: that of the ſkeleton of ſome *holothuria* is exactly ſimilar.

Finally corals, other zoophytes and lithophytes, have hard parts, which are ſometimes cornuous, ſometimes calcarious, and ſometimes ſpongy, but which grow by ſimple juxta-poſition, or at leaſt like ſhells, by the ſucceſſive developement of ſeveral ſtrata. In ſome, this growth takes place externally, and the ſenſible ſubſtance envelopes the old ſtrata, by new ones, with which it again covers itſelf: Such is the caſe in *lithophyta* and *ceratophyta.*

In others, the parts which have once attained their proper hardneſs, no longer increaſe in thickneſs; but new ſhoots or branches are formed at their extremities: Such are all the jointed zoophytes.

All theſe productions contain, like bones and ſhells, a mixture of earthy matter and animal gluten.

ARTICLE III.

Of the Articulations of the Bones and their Motions.

IT is known that the bones are divided according to their forms, into long bones, flat bones, and bones of which all the dimenſions are nearly equal.

We are alſo acquainted with the names given to their eminences and cavities, and thoſe which indicate the ſtate of their ſurfaces: theſe things belong merely to deſcription, and might have been very well expreſſed without ſo great a parade of technical terms.

We ſhall at preſent only notice what relates to the articulations, becauſe they determine the motions of which the bones are ſuſceptible, and becauſe ſome of them have a very great influence in the œconomy of different animals.

Some articulations admit of no motion whatever:—by ſome an obſcure and very limited motion is performed; while others are diſpoſed in ſuch a manner that the bones of which they are compoſed move freely on each other, either in one or in ſeveral directions.

It not only happens that the correſponding bones are differently articulated, in different kinds of animals, but further, there are bones which, though they do not even touch each other in a great number, are however articulated, or ingrafted into one another, in ſome ſpecies. There are even ſome animals in which we obſerve particular kinds of articulation which do not exiſt in any other.

Articulation without motion, or *ſynarthroſis*, which takes place when two flat bones join each other immediately by their edges, is called *ſuture*. It is *denticular* when thoſe edges are notched and indented into one another; *harmonic* when they ſimply touch each other; and *ſquamous* when the thin edge of the one covers that of the other. The bones of the cranium and face of man afford examples of thoſe different kinds of ſutures; theſe are the only bones that are united in this manner in the human body, but we find other examples in other animals. The ribs of the tortoiſe are very broad, and indented with one another, and with the vertebræ of the back to form the ſhell. Theſe ſutures have even impoſed upon ſeveral naturaliſts, who have imagined that foſſil ſhells of the tortoiſe were parts of the human cranium. The parts of the ſternum, or rather the breaſt-plate of the tortoiſe, are likewiſe joined by denticulated ſutures; the ſame kind of junction takes place in ſeveral of the bones that form the oſſeous girdle to which the pectoral fins of fiſhes are attached. The inferior and middle junction is a very perfect indented ſuture in the *ſiluri*; and in ſome other genera it is flattened horizontally in the fore part.

The junction of the bones of the head in mammiferous animals, reſembles very much thoſe we obſerve in the head of man; and in both they diſappear with age in conſequence of the progreſs of oſſification. The bones of the heads of birds and fiſhes are almoſt all connected by harmonic and ſquamous ſutures, and it appears that they unite more readily than thoſe of quadrupeds.

In the lateral parts of the head of fiſhes, and in the flaps of their branchiæ, we obſerve a particular kind of articulation, which reſembles the ſquamous ſuture, in this, that it conſiſts of thin edges, of two flat bones overlapping each other, but which differs in admitting a motion by which the bones can bend or ſlide one upon the other.

Gomphoſis is a ſecond kind of articulation without motion, in which one bone is inſerted as a wedge into a cavity in another bone, or in which it is contained, as a tree in the earth, by its roots. The teeth are the only example of this kind in man and in quadrupeds. The *ſaw fiſh* affords another inſtance in the hooks which are ſunk into both ſides of its long muzzle, and which ſuggeſted the name the animal bears.

Its real teeth, however, are not attached in this manner more than thoſe of *rays* and *ſharks;* but are merely connected to the ſkin, while in other fiſhes they are intimately united with the jaw-bones; or theſe bones anſwer inſtead of teeth.

We ought to notice here a third kind of immoveable articulation, of which there is no example in the human ſkeleton. It is that in which a bone or other hard part inſerted in one cavity, receives in a cavity, in its own baſe, an eminence ariſing from the bottom of that in which it is placed. The nails of *cats*, and of ſeveral other quadrupeds that have ſtrong claws, are joined in this manner to the laſt phalanges of the toes. The tuſks of the *morſe* alſo receive a pivot from the baſis of their alveoli.

Amphiarthroſis, or that kind of articulation which admits only of ſemi-motion, is not thus limited by the figure of the oſſeous parts which conſtitute it, but by the cartilaginous or ligamentous ſubſtance placed between the bones that form the articulation, and which firmly unites them. The bones of the pelvis are joined by this ſort of intermediate cartilage in ſuch a manner that without conſiderable efforts they can ſcarcely have any motion.

The bodies of the vertebræ act more freely upon one another, becauſe the ſubſtance which unites them is thicker and more flexible. Their union takes place in quadrupeds and fiſhes in the ſame manner as in man: but in the neck of birds, and throughout the whole extent of the ſpine of ſerpents, their articulation is completely moveable. They join by ſurfaces which are not united by any other ſubſtance, and which are held together, like the bones of our hand or foot, by a ligamentous capſule. This, in part, accounts for their great mobility.

We may alſo rank among the half-moveable articulations, thoſe of the bones of the carpus and tarſus, which, though provided with few and ſmooth articular ſurfaces, are ſo confined by the ſurrounding ligaments, that they can only move upon each other with conſiderable difficulty, and within a very narrow ſpace. But the diſpoſition of their ſurfaces gives them a more important character, which ſhould induce us to arrange articulations of this kind in the third claſs; that of the free articulations, or *diarthroſis*.

In the joints of the two preceding claſſes, the edges or ſurfaces of the bones which form an union, either come immediately in contact, or are bound one to the other by a ſubſtance which attaches itſelf throughout the whole of their ſurfaces or edges. The perioſteum is continued from one bone to the other, and is more intimately connected at the place of their junction than to any other part. On the contrary, in the moveable articulations of which we have to ſpeak, the oppoſite ſurfaces of the bones are free and diſtinct; each is covered with a ſmooth and poliſhed cartilage; the interval is occupied by a liquor, and ſometimes by ſolid bodies, as glands, or a circular piece of cartilage. Both bones are attached to each other by a continuation of the perioſteum, which does not cover the articular cartilages, but paſſes from the one bone to the other, and thus forms a kind of capſule, in which the articular ſubſtances are incloſed in ſuch a manner that nothing can eſcape from or paſs into the cavity. There are frequently other ligaments either within or without the capſule, which ſtrengthen it, or limit the motions of the bones more than the capſule could of itſelf have done.

The number and rigidity of theſe ligaments, but ſtill more the form of the depreſſions and eminences of the articular ſurfaces of the bones, govern the extent and direction of the motions.

A bone articulated with another by one of its extremities, can only move upon it in two ways, viz. by flexion or torſion: flexion takes place when the extremity of the bone moved, which is fartheſt from the joint, approaches the bone which is fixed; for when the two bones are in a ſtraight line, that extremity is moſt diſtant from the latter. Torſion, or twiſting, takes place when the bone moved turns round its own axis, or round an imaginary axis, paſſing through the articulation.

It will be readily perceived that torſion can only be performed when the articular ſurfaces are plane or ſpherical, and that the latter only are capable of flexion in every direction; but when the ſurfaces are cylindrical, or each partly convex and partly concave, the motion muſt be confined to one direction; the bone will always remain in the ſame plane ſo long as that with which it is connected is not diſplaced, and will deſcribe the ſegment of a circle, having its centre in the articulation.

That ſpecies of joint which admits of only one kind of flexion is called *ginglymus*, that which allows it in every direction *enarthroſis*, or *arthrodia*, according as the ſurfaces are more or leſs convex, and the flexions more or leſs complete.

When one bone is connected to another by two extremities, and is reduced to ſimply turning round, it forms a kind of ginglymus, which is called *rotation*.

The head is attached to the trunk, the lower jaw to the head, and all the parts of the extremities are attached to each other by theſe different kinds of moveable articulations; but each particular part is not always joined in the ſame manner in the different claſſes of animals. The head in mammalia is articulated by ginglymus; that of birds by arthrodia. The radius in man is connected by arthrodia with the humerus, and by rotation with the ulna. In the *rodentia*, *hogs*, &c. the radius is attached to the humerus by ginglymus, and is immoveable at its junction with the ulna; in ſome ſpecies it is even completely united.

Some fiſhes exhibit particular modes of moveable articulations, of which the ſkeleton of man, and other mammiferous animals, afford no examples.

The firſt, which may likewiſe be referred to ginglymus, is the annular articulation, in which a bone is, as it were, ſtrung, like a bead, upon a branch, or at leaſt upon a cylindrical eminence, and almoſt detached from other bones. The firſt ſpines of the anal fins of ſome *chætedons* are articulated in this manner.

The ſecond is an articulation which can be rendered immoveable at the pleaſure of the animal. The moveable bone has a ſmall hook; and it is in the power of the animal, by turning that bone round, to inſert the little hook in a hole in the immoveable bone. In this manner, by a ſlight flexion, the moveable bone is ſo linked, that its poſition cannot be changed except by a motion preciſely contrary to that which faſtened it to the other, and every effort in another direction is uſeleſs. It is thus that the *ſiluri* and *gaſteroſtei* fix the firſt ſpines of their pectoral fins, when they wiſh to uſe them in combat.

We have already noticed the kind of moveable articulation which takes place between the thin edges of two flat bones, and which allows the one to ſlide over the other. In birds we find another kind of joint, which admits a ſimilar motion, but which is produced between plane ſurfaces. The palatine arch of the ſuperior bill of the *duck* has this kind of ſurface, correſponding with others ſituated at the baſe of the cranium.

The moluſca have no articulations except in their ſhells. Thoſe of the bivalvular kind are, in general, articulated by ginglymus, more or leſs compóſed, in proportion to the number of indentations the ſhells form with one another. They have neither capſule nor articular cartilages. Externally there is an elaſtic ligament, which forces the valves to open when the muſcles that ordinarily keep them ſhut are relaxed. The different pieces which form the multivalve ſhells, are either connected together by a common cartilaginous membrane, or they are immediately attached to the body of the animals. The *chitons* move their ſhells by making the edges ſlide one upon the other. In the *anatifæ* there is only one common motion for opening and ſhutting, which is performed by ginglymus, as in the bivalves. The opercula of ſome univalve ſhells, particularly the *neritæ*, are alſo articulated by ginglymus to the principal ſhell.

The cruſtacea and inſects have a common ſyſtem of articulation, which depends upon the poſition of their hard parts exterior to the muſcles. As theſe hard parts form a kind of caſe, the interior of which is occupied by the muſcles, they cannot be articulated by ſimple and complete ſurfaces; they, therefore, can neither have arthrodia nor enarthroſis. All their moveable articulations are reducible to three kinds; ginglymus is the only one which exiſts in thoſe parts that require a ſolid point of ſupport, becauſe, the ſcaly coverings of the members being tubular, they muſt be ſupported, at leaſt, at two points of their circumference. This neceſſarily determines the articulation by ginglymus. With reſpect to the parts which require no ſolid point of ſupport, they are either ſimply ſuſpended by ligaments, or articulated by *incluſion*.

Incluſion occurs when one part enters and is encloſed in another. In this manner the limbs of inſects are incaſed in the thorax, and the annular coverings of their abdomen into one another. As the part which receives, and that which is received, are each the ſegment of a ſpheroid, the laſt may perform the motion of turning; it may alſo penetrate more or leſs into the firſt, either by the whole of its circumference, or more on the one ſide than on the other; but what is properly called flexion, cannot be performed by this articulation.

The parts of inſects which are articulated by ginglymus, and which are principally the different portions of their limbs, are very much hollowed on the ſide where the flexion muſt neceſſarily be moſt complete; the interval is ſupplied with a flexible membrane, and there is no other ligament. The articular tubercles and depreſſions are ſo arranged that they cannot be luxated without being broken: the ſlight curvatures, which form a kind of hooks, tend ſtill further to produce this effect.

Article IV.

Of the Tendons, of the Compoſition of the Muſcles, and of their Action.

The mode of articulation determines the number, kind, and direction, of the motions which the bones that form it are capable of performing.

The number and direction of the muſcles attached to the bones, determine the number, kind, and direction of the motions they really do perform.

The muſcles are attached to the bones by tendons. The tendon, like the muſcle, is of a fibrous texture; but its fibres are cloſer, more firm, and of a ſilver whiteneſs. It is penetrated by fewer veſſels, and no nerves. Its ſubſtance is almoſt entirely gelatinous; and it poſſeſſes neither ſenſibility nor irritability; it forms only a paſſive link, by which the muſcle acts on the bone.

Portions of tendon are, however, found both in the inſide and on the ſurface of ſeveral muſcles. Even thoſe tendons by which the muſcles are inſerted into the bones, penetrate a certain length into the fleſhy ſubſtance, where they are interlaced in different manners. The form of the tendons varies as much as that of the muſcles. Thoſe tendons which are broad and thin are called *aponeuroſes*.

In its gelatinous quality the tendon has a ſtrong affinity to the oſſeous principle, or phoſphat of lime: it receives it with facility, particularly when its action is frequently repeated, and when it is employed in violent motions. Heavy birds, that walk much, have the tendons of their limbs oſſified at a very early period. The ſame thing happens to the *jerboa*, and other animals, that conſtantly leap with their poſterior limbs.

The tendons of the cruſtacea and inſects, in the muſcles of the thigh and limbs, differ, in their nature, from the tendon of red-blooded animals; they are hard, elaſtic, and have no apparent fibres; they are covered by the fleſhy fibres which are inſerted into their ſurfaces. The tendon is frequently articulated with the ſcaly caſe which it has to move, in the ſame manner as one bone is articulated with another; it is connected with that caſe by a membranous ligament. This is particularly obſervable in the great claws of *cray-fiſh*.

The tendons of the moluſca are not apparent; but this is, doubtleſs, owing to the colour being the ſame in the tendinous and the fleſhy parts. With reſpect to their chemical nature, it is certain that maceration and concoction completely detach the muſcles from the hard parts, a circumſtance which can only happen in conſequence of the diſſolution of their connecting medium; that medium, therefore, does not conſiſt of fibrine, as in the reſt of the muſcle, ſince, if it did, it would be indiſſoluble.

It is probable that the elementary muſcular fibres all exerciſe an equal force at the moment of their contraction; but the manner in which they are diſpoſed in the muſcle, and the ſituation of the muſcle itſelf, with reſpect to the bone, or part it has to move, afford a more or leſs advantageous employment of that force. The action of a muſcle, therefore, cannot be eſtimated by its maſs only, nor by the number of the fibres that compoſe it. Two other circumſtances are neceſſary to be conſidered; the compoſition of the muſcle, and its inſertion.

The muſcles are divided into ſimple and compound; the *ſimple* are thoſe in which all the fibres have a ſimilar diſpoſition; the moſt common are the *ventriform;* their fibres are nearly parallel, and form a long bundle, of a round ſhape; their fleſhy parts ſwell, more or leſs, in the middle, which is called their belly; they become ſmaller towards the two extremities where they terminate in the tendons. Another kind of ſimple muſcle conſiſts of thoſe that are flat, and have parallel fibres; they form a ſort of fleſhy membrane, which, inſtead of ending in ſmall tendons, is terminated by aponeuroſes, or tendinous membranes. Both theſe kinds ſometimes have tendons, or aponeuroſes, in their middle, and at other points of their bodies. It is obvious that, in either, the total action is equal to the ſum of all the particular actions of the fibres, and that, if the action experiences any diſadvantage, it is owing to the mode of the inſertion, and not to the compoſition of the muſcle. This is not the caſe with the two other kinds of ſimple muſcles—the *radiated* and the *penniform*.

Radiated muſcles are thoſe that have their fibres diſpoſed like the radii of a circle, and which, proceeding from a baſe more or leſs extended, incline towards each other, and are inſerted in a ſmall tendon.

Penniform muſcles have their fibres diſpoſed in two rows, which unite in a middle line, and form, with each other, angles more or leſs obtuſe, ſo that they reſemble the feathers of a quill. The tendon is the continuation of this middle line.

It will be readily perceived that, in theſe two kinds of muſcles, the total or reſulting force is leſs than the ſum total of the component forces, and that it is only equal to the ſum of the diagonals of the parallelograms, which may be formed from every two fibres that unite in producing one angle.

A *compound* muſcle is formed by the aſſemblage of ſeveral which unite in one common tendon. Theſe muſcles may be ſimilar in their nature, but ſometimes we find very different kinds, as the radiated, the ventriform, &c. uniting to form one compound muſcle. The particular action of each may be eſtimated according to the preceding obſervations. Their total action muſt afterwards be calculated according to the degree of their inclination.

Laſtly, there are ſome muſcles which have only one belly, with divided tendons; others have ſeveral fleſhy parts, and ſeveral tendons interlaced together in different ways. Theſe laſt may be called *complicated muſcles.*

From theſe different diſpoſitions reſult the abſolute force of the muſcles; their inſertion determines their real effect. The muſcular inſertions may be referred to eight diſtinct kinds.

Muſcles may be deſtined to compreſs the ſoft parts contained in a certain cavity; they then envelope that cavity in different directions, in the form of membranes or bands. Such is the diſpoſition of our abdominal muſcles and diaphragm; ſuch is that of the muſcles of ſlugs, other moluſca, and naked worms, which can contract themſelves in every direction. When theſe muſcles act together, it is for the purpoſe of expelling ſome matter from the body, as eggs, excrements, &c. but they uſually act alternately, and then their effect is to enlarge one of the diameters of the cavity they ſurround, and to diminiſh the other. Thus, at each inſpiration, the abdomen becomes wider and ſhorter, while the contrary happens on each exſpiration. In this manner *ſlugs* and *leeches* lengthen and ſhorten themſelves, by moving, in the firſt caſe, their tranſverſe or annular muſcles, and, in the ſecond, their longitudinal muſcles.

In this manner, alſo, the muſcles act which are deſtined to lengthen or ſhorten, to relax or compreſs, any ſoft part of the body, ſuch as the tongue of man or quadrupeds, or the horns of ſnails.

The heart, the inteſtines, the arteries, &c. have likewiſe muſcles of this kind.

Other muſcles are calculated to widen or contract ſome ſoft aperture: ſome of theſe ſurround the orifice like rings, and are called *ſphincters*; others are inſerted in a manner more or leſs directly in the edges of the opening. When they are uniformly extended around the orifice, it preſerves its figure, and is always dilated, or contracted, in the ſame manner. The eye-lid of the *moon fiſh*, and the anus of the *ſnail*, afford examples of this kind of motion. When, however, theſe muſcles have different directions, and make different angles with the edges they have to move, the form of the aperture is very variable; ſuch, for inſtance, are the lips of man. No animal comes near him with reſpect to the mobility of this part; and no one, therefore, poſſeſſes ſo expreſſive a phyſiognomy.

Another employment of the muſcles is to extend and fold back, like curtains, membranes that are deſtined to cover certain parts, ſuch as the eye-lids of man, quadrupeds, and birds. When theſe muſcles are placed in the body of the membrane, their diſpoſitions are ſimilar to that of which we have juſt ſpoken; but, when they are ſituated externally, they have the form of very complicated pullies. We ſhall explain them when we deſcribe the eye of birds.

A fourth employment of the muſcles may be that of turning, or rolling about, a globular maſs, which is free, and ſupported on every ſide, as the eye in the orbit, or the mouth of the ſnail in its head. The muſcles then ſurround this part as the portions of a hoop, which is turned to the ſide of the muſcle that contracts moſt ſtrongly.

Theſe four modes of action are, in reality, all referable to that of the ſphincters, or circular muſcles. They are always performed by a girdle, or portions of a girdle, which contract, or cloſe upon the parts they ſurround.

The following mode, in which the muſcles act on the bones, and other hard parts, may be compared to the action of ropes, drawing a reſiſting object in a certain direction. The ſubject which is thus drawn, may be equally acted upon in all its parts, ſo as to remain always parallel to itſelf. Such is the motion by which we elevate or depreſs our os hyoides and our larynx. The muſcular fibres may then be regarded as ropes pulling in the direction in which the motion of the part acted upon is to be performed. This is the moſt advantageous manner in which they can be employed; and we find it exiſts in the *ſterno-hyoideus* and the *genio-hyoideus.* If the muſcles diverge, there is an equal quantity of action on both ſides, and the reſulting force is then employed in the moſt advantageous manner: this is what we obſerve in the *mylo-hyoideus* and *ſcapulo-hyoideus.*

But when the bone acted upon is articulated at any particular point, it cannot be elevated or depreſſed all at once: It muſt then be conſidered as a lever having its fulcrum in the articulation.

When the articulation is between the two extremities, and the muſcles are placed at one of them, the bone forms a lever of the firſt rank. We have an example of this kind in the mandible of the *cray fiſh.* The muſcles which are attached to the olecranon and os calcis, alſo furniſh ſimilar examples. The moſt remarkable is the tibia of the birds called *grebes* and *divers,* which has a long apophyſis elevated above the knee, and which ſerves as a ſubſtitute for the patella.

But the moſt ordinary caſe is that in which the articulation is at one of the extremities of the bone, then the moſt favourable poſition for the muſcle is when it riſes from another bone parallel to that which it has to move, or which forms with it only a very ſmall angle; ſuch is the caſe with the muſcles called *intercoſtales*, *interſpinales*, and *intertranſverſi*: and the muſcles which draw together certain bones that have a fan-like figure, as thoſe of the membranes, which cover the branchiæ of fiſhes, and the wings of the *flying dragon*. Still, however, thoſe muſcles have an obliquity which is not rendered neceſſary by the poſition of the parts to which they are attached, and which conſiderably diminiſhes their power.

The muſcles which cloſe the mouth of man, and the bill of birds, may alſo be compared to the preceding, with reſpect to their advantageous poſition on account of their little obliquity; but they are inſerted much nearer to the point of ſupport than the former, a circumſtance which alſo conſiderably diminiſhes their force.

The laſt mode of inſertion, and the moſt common of all, is when a muſcle attached to one bone is inſerted into another, which laſt bone is articulated mediately or immediately with the firſt, and may be extended until they both form a right line, or inflected ſo as frequently to make a very ſmall angle. This mode is the moſt diſadvantageous of all, from the extreme obliquity of the inſertion, when the moveable bone is extended, and on account of its proximity to the fulcrum. The firſt of theſe inconveniences is partly corrected by what are called the heads of bones. Their articular extremities are uſually enlarged, ſo that the tendons of the muſcle, by turning round a convexity in order to be inſerted below it, form more obtuſe angles with the lever or body of the bone than would be practicable if the head did not exiſt; this diminiſhes and renders leſs variable the obliquity of their inſertion.

As to the proximity of the fulcrum, that was neceſſary to prevent the members from being monſtrouſly large in the ſtate of flexion, but particularly for producing a prompt and complete flexion: for as the muſcular fibre loſes only a determinate fraction of its length in contraction, if the muſcle were inſerted at a greater diſtance from the joint, the moveable bone would only be approximated to the other by a ſmall angular quantity: on the contrary, by inſerting it near the apex of the angle, a very ſmall contraction occaſions a conſiderable approximation. This effect is produced by the muſcular force; and in this manner theſe ſort of muſcles exerciſe a power which ſurpaſſes all imagination.

Comparative anatomy, however, affords examples of muſcles inſerted at a conſiderable diſtance from the fulcrum. Birds have one which extends from the top of the ſhoulder to the extremity of the fore-arm neareſt the carpus: But this happens, becauſe all the angle formed by the humerus and ulna, is in them occupied by a membrane intended to augment the ſurface of the wing.

It is alſo in conſequence of the ſmall contraction of the muſcular fibre, that the ſhort bones, which muſt be completely inflected, are moved by muſcles attached to bones at a diſtance. The vertebræ and the phalanges of the fingers are in this ſituation. Muſcles extended from the one to the other of thoſe bones would not have produced a ſufficient degree of flection: beſides, in the phalanges they would have made the fingers too thick. It is alſo neceſſary that the tendons of theſe muſcles ſhould be attached to the bones over which they paſs: were not this the caſe, whenever the phalanges were bent ſo as to form an arch, the muſcles and their tendons would remain in a ſtraight line, and appear like its chord. Hence the neceſſity for the annular ligaments, the ſheaths, and the perforations. This laſt organization, which occurs only in the flections of the fingers and toes of man, quadrupeds, reptiles, and the toes of birds, conſiſts in the muſcles which have to extend fartheſt, being placed near to the bones, and their tendons, perforating thoſe of the muſcles, which are inſerted at a ſhorter diſtance, and which lie over the firſt. When there is only three phalanges, there is but one perforation:

but birds, which have one toe with four, and another with five phalanges, have two perforations, and conſequently three muſcles; one perforated, one perforating and perforated, and one perforating.

The vertebræ which have to perform great motions; for example, thoſe of the neck in birds, and the tail in quadrupeds, have alſo very distant muſcles; but their long ſlender tendons are incloſed in ſheaths, which they do not leave until they are oppoſite the points into which they are to be inſerted.

ARTICLE V.

General Remarks on the Skeleton.

WE have already ſhewn that the ſkeleton is a collection of hard parts, ſupporting the body, of which it forms as it were the frame. In the invertebral, or white-blooded animals, it is external; and then its form is the ſame as that of the animal, ſince it incloſes all the other parts. In the vertebral animals, it only determines the moſt important forms and proportions. Their ſkeletons, therefore, do not differ ſo much as their external figures; even amongſt them all, there are reſemblances which one would not ſuppoſe to exiſt, from the aſpect of the parts they ſuſtain.

The bones of which the ſkeletons are compoſed, are in general articulated in ſuch a manner as to form a whole, all the parts of which are connected: there are, however, exceptions to this rule; the bones which ſupport the tongue in quadrupeds and birds, are not connected with the other bones, except by ſoft parts, though in fiſhes they are properly articulated with the reſt of the ſkeleton. The whole of the anterior extremities are only attached to the body by muſcles in quadrupeds that want the clavicles; but in other quadrupeds, they are joined to the ſternum by ſingle clavicles, and by double ones in birds.

In fiſhes they are strongly connectd with the ſpine by a bony girdle.

On the other hand, their poſterior extremities are generally free, and ſimply fixed in the fleſh, while the other animals have them ſtrongly attached to the reſt of the ſkeleton by the medium of the pelvis.

The bones which compoſe the ſkeleton, preſent three principal diviſions—the head, the trunk, and the extremities.

The head is never wanting: the extremities are totally wanting in ſerpents and ſome fiſhes; the poſterior extremities are wanting in the apodes claſs of fiſhes, that is to ſay, in thoſe that have no ventral fins, and in the cetacea amongſt mammalia. The anterior extremities only are wanting in one ſpecies of lizard. No vertebral animal has more than four extremities, unleſs we include in that number the kind of wing which belongs to the flying-dragon, a little animal next to our lizard.

The trunk is formed by vertebræ (the whole of which is called the ſpine of the back), the ribs and the ſternum. The vertebræ are never entirely wanting, though their number is exceedingly variable. The ſternum is abſent in ſerpents and fiſhes; unleſs we ſhould chooſe to give that name to the anterior part of the bony girdle which ſupports the pectoral fins, or anterior extremities of fiſhes. The ribs are wanting in *frogs*, *rays*, *ſharks*, and a great number of cartilaginous fiſhes.

Thoſe vertebræ which ſuſtain the ribs are called *dorſal*. Thoſe which are ſituated between the dorſal and the head, *cervical*; thoſe which are poſterior to the dorſal, *lumbar*; thoſe which are joined to the pelvis or poſterior extremities, *ſacral* or *pelvic*; and thoſe which form the tail, *coccygeal* or *caudal*. Only a very ſmall number of mammalia, (the ternate bats,) and the frog kind, have no coccyx. Several fiſhes have no neck. It is obvious that in the animals that have no ribs, the diſtinction of the three firſt kinds of vertebræ cannot take place, and that the diſtinction of the three laſt diſappear in thoſe that have no poſterior extremities, or where thoſe extremities are not attached to the ſpine.

The ribs which proceed from the vertebræ and join the ſternum are called true ribs: thoſe which do not extend ſo far, are called falſe ribs; the latter are always poſterior in quadrupeds. In birds, they are both before and behind: this diſtinction ceaſes to prevail in the animals that have no ſternum. Particular denominations muſt be given to the ribs which proceed from the ſternum, and do not join the vertebræ, of which the *crocodile* affords an example; and thoſe which, coming from the vertebræ, unite anteriorly with the correſponding ribs, without any ſternum exiſting between them, as we find in the *cameleon*.

The head is always placed at the anterior extremity of the vertebral column, and that which is oppoſite to the tail. It is divided into three parts, which may vary in their relative proportions, but which are never wanting. Theſe diviſions are, (1) the cranium, which contains the brain, and in the partitions of which are ſituated the cavities of the internal ear, and frequently a part of thoſe of the noſe; (2) the face, which contains the orbits of the eyes, the naſal cavities, and which is terminated inferiorly by the upper jaw; (3) laſtly, the lower jaw; this laſt is always moveable even in the *crocodile*, though the contrary has been aſſerted. The upper jaw is immoveable in man, in quadrupeds, and in ſome reptiles, as the *tortoiſe*, the *crocodile*, &c. But it is more or leſs moveable in birds, ſerpents, and fiſhes.

The extremities, when perfect, are divided into four parts; thoſe which belong to the anterior extremities are, the ſhoulder, the arm, the fore-arm, and the hand; thoſe of the poſterior are, the hip, the thigh, the leg, and the foot: theſe diſtinctions do not hold amongſt fiſh whoſe extremities conſiſt only of boney rays; that is to ſay, of bones conſtituted like a fan, and articulated to parts which correſpond with the ſhoulder or hip: ſtill, however, ſome analogy may be found between thoſe parts and the diviſion of the extremities in other animals.

The ſhoulder conſiſts of the ſcapula, placed againſt the back, and the calvicule, attached to the ſternum.—The laſt is wanting in ſome quadrupeds, and the cetacea, as will be ſeen hereafter, but is double in birds, tortoiſes, frogs, and many lizards:—the ſcapula is never wanting when the extremity exiſts. The arm is formed of one bone only. The fore-arm is almoſt always formed of two: even when the fore-arm has but one bone, there generally appears a furrow, or ſome other veſtige of its ordinary compoſition. The hand varies with reſpect to the number of its bones; but thoſe which exiſt in it always form a wriſt or carpus, the body of the hand or metacarpus, and the fingers: this organization prevails even in birds which have their fingers enveloped in a ſkin covered with feathers; it likewiſe prevails in the cetacea, in which the whole of the anterior extremity is reduced to the figure of an oar or fin.

The parts of the ſkeleton are uſually diſpoſed with a ſtrict regard to ſymmetry; ſo that the two halfs, formed by a longitudinal ſection, are counter-proofs of each other: In only one kind of fiſhes, called *pleuronectes*, which includes *ſoles*, *plaice*, *turbots*, &c. the head is ſo formed that the two eyes and the two noſtrils are on the ſame ſide; but the ſymmetry of the remainder of the ſkeleton is preſerved.

Each claſs and each order of animals hav particular characters relative to their ſkeleton: they conſiſt in the general form of the trunks and the extremities, in the preſence or abſence of the latter, and in the number of thoſe different parts.

We ſhall explain all theſe particulars in detail in the following Lectures: it may be proper, however, to remark here, that though an animal of one claſs has ſome reſemblance to thoſe of another, in the form of its parts, and the uſe it makes of them, that reſemblance is external, and affects the ſkeleton only in its proportions, but not in the number nor the arrangement of the bones: *bats*, for example, appear to have wings, but an attentive examination demonſtrates that they are real hands, the fingers of which are merely ſomewhat lengthened: in the ſame manner, though the *dolphins* appear to have fins all of one piece, we find under the ſkin all the bones that compoſe the anterior extremities of the other mammalia, ſhortened and rendered almoſt immoveable. The wings of *penguins*, which likewiſe reſemble fins in one piece, contain internally the ſame bones as thoſe of other birds.

LECTURE THIRD.

OF THE BONES AND MUSCLES OF THE TRUNK.

Article I.

Of the Bones of the Spine.

A *In Man.*

The ſpine of Man is divided into five regions, viz. (1) the *caudal*, or *coccygeal*; (2) the *ſacral*, or *pelvic*; (3) the *lumbar*; (4) the *dorſal*; (5) the *cervical*, or *tracheal*.

The caudal region is of ſmall extent; it conſiſts of three or four little bones, articulated with each other, and ſupported by the point of the os ſacrum, with which the firſt piece is frequently intimately united.

The ſacral region is compoſed of five vertebræ, which are conſolidated into one bone, called the os ſacrum; it is parabolic, flat, and thin, at the lower end; concave before, and convex behind: its upper part is articulated with the body of the laſt vertebra of the loins by an oval ſurface, cut obliquely from the front backward, and forming, with the loins, a ſharp angle anteriorly. This angle is more acute in women than in men. Two other ſurfaces, directed backward, ſerve for its junction with the oſſa ilii. The os ſacrum is perforated by four pair of holes, which afford paſſage for the nerves. Poſteriorly we obſerve eminences that correſpond to all the proceſſes of the vertebræ, which formerly compoſed this bone. The ſpinous proceſſes, in particular, are very conſpicuous: the two laſt are bifurcated.

There are five lumbar vertebræ; their bodies are more broad than the vertebræ above them; their ſpinous proceſs is horizontal, compreſſed, and ſomewhat truncated at the point; their ſuperior articular proceſſes have their ſurfaces turned inward, the inferior have theirs turned outward; their tranſverſe proceſſes are long, flat, and pointed directly to the ſides.

The dorſal vertebræ, which are twelve in number, diminiſh in ſize from the laſt to the fourth or fifth, and afterwards increaſe in ſize up to the firſt: their bodies are ſimilar to thoſe of the lumbar; their ſpinous proceſſes are long, ſlope downward, and have the ſhape of a triangular priſm; the three higheſt are more elevated, and become almoſt horizontal; the ſuperior articular proceſſes have their ſurfaces directed backward, and the inferior have theirs turned forward; the tranſverſe proceſſes are ſhort, horizontal, and turned ſomewhat backward; anteriorly there is a ſmall flat ſuperficies, againſt which the tubercle of the correſponding rib reſts. Theſe ſuperficies are turned obliquely downward in the ſuperior dorſal vertebræ, and upward in the inferior. There is, beſides, at the lateral edge of each articulation of their bodies, a ſmall cavity, common to every two vertebræ, which receives the head of the rib.

The loweſt five of the cervical vertebræ are ſimilar to thoſe of the back, but ſmaller. The upper ſurface of each of their bodies is hollow, and receives the inferior ſurface of the preceding vertebra. The plane of theſe ſurfaces is inclined forward; their tranſverſe proceſſes are inclined ſomewhat forward and downward. They are remarkable for an excavation in the form of a ſemi-canal, and a ſmall hole. The ſpinous proceſſes are forked, except the two laſt.

The ſecond vertebra of the neck, called *axis*, or *odontoides*, differs from the others in its ſpinous proceſs, which is much broader, and more elevated; by the hole in its tranſverſe proceſs, which, inſtead of being perforated vertically, is directed tranſverſely, and thus forms an oblique canal; by a pointed proceſs, which riſes from the upper ſurface of the body of the vertebra, and which has an articular ſurface anteriorly; finally, by its junction with the firſt vertebra, which is performed by the means of two flat ſurfaces correſponding to the articular proceſſes of the other vertebræ.

The firſt cervical vertebra, which is ſtill called the *atlas*, is merely a ring; it has hardly any ſpinous proceſs, and no body; but it has two ſurfaces for articulation with the ſecond vertebra, and two more which receive the condoyles, by which it is connected with the head. The tranſverſe proceſſes are very long, and each has a foramen.

The length of the neck is nearly equal to one half of that of the back, and to two-thirds of that of the loins.

When man ſtands erect, the vertebral column has four curvatures. The region of the ſacrum is concave before, the loins are convex, the back is concave, and the neck is convex.

The vertebræ of man are ſuſceptible of a number of ſmall motions with reſpect to each other; but theſe motions, though very conſpicuous in the whole of the ſpine, are very obſcure between any particular bones. Each vertebra can move a little forward, by reſting on the anterior part of its body; backward, by inclining in the direction of the ſpinous proceſſes; and, finally, ſideways, by yielding a little in the direction of the oblique proceſſes. Theſe articulations are firmly ſupported by a number of ſtrong ligaments; but to deſcribe them in one vertebra is almoſt ſufficient for a knowledge of the whole.

The body of each vertebra is covered, both above and below, by an elaſtic cartilaginous ſubſtance, the ſolidity of which gradually diminiſhes from the centre to the circumference. The articular proceſſes have alſo each their capſules. All the anterior part of the bodies of the vertebræ is covered by a large and very ſolid coat, formed of tendinous or ligamentous fibres, which extends from the firſt cervical vertebra to the os ſacrum. Behind the bodies in the interior of the vertebral canal, there is likewiſe another tendinous covering, which extends from the tooth-like proceſs of the ſecond vertebra to the os ſacrum. Each proceſs, whether ſpinous or tranſverſe, has alſo a ſmall ligament, which unites it to the preceding or the following proceſs. The laſt vertebra is connected in the ſame manner with the os ſacrum.

B *In other Mammiferous Animals.*

The ſpine of Quadrupeds may differ in the number of the vertebræ, in the reſpective proportions of the neck, back, loins, ſacrum and coccyx, in the total curvature, and in the form of each vertebra.

1. *Number of the Vertebræ in Mammalia.*

The number of the cervical vertebræ is always ſeven, except in the *three-toed ſloth*, which has nine. The *cetacea* have frequently two or more oſſified together; for example, the two firſt in the *dolphin* and *porpoiſe*, and the ſix laſt in the *cachalots*; but the parts are always perceptible; they are merely joined by anchyloſis.

As to the other vertebræ, their different numbers, in the different ſpecies, have no conſtant relation with their natural families, as will appear from the table underneath.

In the cetacea there is, ſtrictly ſpeaking, no pelvis, and, conſequently, no diſtinction can be eſtabliſhed between the vertebræ of the loins, thoſe of the ſacrum, and thoſe of the tail.

Only a very ſmall number of mammalia want caudal vertebræ, among which are the *ternate bats*.

TABLE of the Number of the Vertebræ in Mammiferous Animals.

Species.	Dorſal Vertebræ.	Lumbar Verteb.	Sacral Verteb:	Caudal Vertebræ.
Man	12	5	5	4
Orang-outang	12	4	3	4
Jocko	13	5	4	5
Long armed Ape	14	3	6	
Coaita, or 4 fingered Monkey	14	3	2	32
Weeping Monkey	14	7	4	25
Silky Monkey	12	7	1	26
Red Monkey	12	7	3	more than 16
Rib-noſed Ape	12	7	1	13
Hair-lipped Monkey	12	7	1	5
Chineſe Monkey	11	7	3	20
Baboon	12	7	1	31
Magot, or Barbary Ape	12	7	1	3
Mandril	12	7	3	13
Pongo	12	4	3	4
Howling Baboon	14	4	5	25

Species.	Dorſal Vertebræ.	Lumbar Verteb.	Sacral Verteb.	Caudal Vertebræ.
Maucaco	12	7	3	18
Lori	15	9	1	9
Tarſier, or Woolley Jerboa	14	5	3	more than 17
Vampyre, or Ternate Bat	12	4	1	0
Common Bat	11	5	4	12
Noctule, or Great Bat	12	7	3	6
Horſe-ſhoe Bat	12	6	3	12
Flying Lemur	12	6	1	22
Hedge-hog	15	7	4	12
Tanrec	15	6	3	8
Shrew	12	7	3	17
Mole	13	6	7	11
White Bear	13	6	7	11
Brown Bear	14	6	5	more than 4
Badger	15	5	3	16
Glutton	16	5	3	18
Coati	14	6	1	more than 10
Racoon	14	7	3	20
Otter	14	6	3	21
Martin	14	6	3	18
Weaſel	14	6	3	14
Civet	13	6	3	20
Lion	13	6	3	23
Tiger	13	7	4	19
Panther	13	7	3	24
Couguar, or American Lion	13	7	3	22
Cat	13	7	3	22
Dog	13	6	3	22
Wolf	13	7	3	19
Fox	13	7	3	20
Hyena	16	4	2	more than 8
Cayenne Opoſſum, or Crab-eater	13	6	5	more than 16
Marmoſe, or Murine Opoſſum	13	6	1	29
Phalanger, or Surinam Opoſſum	13	6	1	30
Porcupine	14	5	4	more than 8
Hare	12	7	4	20
Rabbit	12	7	2	20
Cabiai	13	6	2	more than 4
Guinea Pig	13	6	4	6

Species.	Dorſal Vertebræ.	Lumbar Verteb.	Sacral Verteb.	Caudal Vertebræ.
Paca, or Spotted Cavy	13	6	5	7
Agouti	12	8	4	7
Beaver	15	5	3	23
Flying Squirrel	12	8	3	13
Marmotte	13	7	6	22
Field Mouſe	13	7	3	15
Water Rat	13	7	4	23
Black Rat	13	7	3	26
Norway Rat	13	7	4	23
Common Mouſe	12	7	4	24
Field, or Harveſt Rat	12	7	3	23
Hamſter	13	6	4	15
Fat Dormouſe	13	7	2	18
Garden Dormouſe	13	7	4	24
Ant-eater	16	2	4	40
Pangolin	15	5	3	28
Long-tailed Manis	13	5	2	45
Armadillo	11	4	3	30
Two-toed Sloth	23	2	4	more than 7
Three-toed Sloth	14	4	3	13
Elephant	20	3	4	24
Hog	14	5	3	more than 4
Tapir	20	4	3	12
Rhinoceros	19	3	4	22
Camel	12	7	4	17
Dromedary	12	7	4	18
Stag	13	6	3	11
Camelopard	14	5	4	18
Antelope	13	6	5	15
Gazelle	13	5	5	11
Chamois	13	5	4	more than 7
Goat	13	6	4	12
Sheep	13	6	4	16
Ox	13	6	4	16
Horſe	18	6	2	17
Couaga	18	6	7	18
Seal	15	5	2	12
Dolphin	13	In all 66		
Porpoiſe	13			

2. *Proportions of the Spine in different Quadrupeds.*

The length of the neck does not depend on the number of the cervical vertebræ, for, as we have already obſerved, that number is almoſt always the ſame in all quadrupeds.

In general, the length of the neck is ſuch, that, added to the head, the length of both is equal to the height of the animal's ſhoulders from the ground. Were not this the caſe, quadrupeds could not eaſily either reach the herbs on which they feed, or the water they drink. Among all thoſe in which this rule is obſerved, the bulk of the head is in an inverſe proportion to the length of the neck, otherwiſe the muſcles would not be able to raiſe it up.

This rule, however, is not adhered to in the animals that lift food to the mouth by the means of hands, or feet conſtructed like hands; nor in the elephant, in which the proboſcis is ſubſtituted for hands; nor in the cetacea, which live and obtain their food in water, and which, of all mammalia, have the ſhorteſt necks.

The ſhape of the body in animals, whether ſlender, or thick and ſhort, is principally determined by the length of loins, which depends upon the number of the lumbar vertebræ. This is obſervable in the *lori*, &c.

*TABLE of the Length in Metres * of the Regions of the Spine in Mammiferous Animals.*

NAMES.	Total.	Cervical.	Dorſal.	Lumbar.	Sacral.	Caudal.
Man	0,74	0,11	0,30	0,16	0,14	0,03
Orang	0,26	0,04	0,11	0,05	0,04	0,02
Pongo	0,66	0,12	0,29	0,13	0,10	0,02
Sai	0,66	0,03	0,09	0,09	0,03	0,42
Ternate Bat	0,19	0,05	0,07	0,03	0,04	
Common Bat	0,11	0,01	0,02	0,01	0,01	0,06
Mole	0,135	0,015	0,03	0,03	0,03	0,03
Hedge-hog	0,19	0,02	0,07	0,04	0,02	0,04
Sea Bear	0,39	0,31	0,44	0,28	0,17	0,19
Seal	0,72	0,12	0,24	0,15	0,06	0,15
Glutton	0,70	0,11	0,22	0,13	0,04	0,20
Racoon	0,64	0,06	0,14	0,10	0,04	0,30
Otter	0,98	0,11	0,24	0,13	0,03	0,47
Lion	1,51	0,27	0,44	0,35	0,09	0,36
Cat	0,71	0,08	0,15	0,13	0,03	0,32
Wolf	1,08	0,18	0,28	0,21	0,05	0,36
Opoſſum	0,68	0,05	0,11	0,10	0,02	0,40
Hare	0,48	0,07	0,12	0,17	0,03	0,09
Guinea Pig	0,20	0,04	0,06	0,06	0,02	0,02
Three-toed Sloth	0,54	0,09	0,23	0,04	0,08	0,10
Long-tailed Manis	0,84	0,03	0,10	0,06	0,04	0,61
Elephant	2,85	0,32	1,05	0,25	0,21	1,02
Hog	1,25	0,17	0,42	0,25	0,11	0,30
Rhinoceros	1,85	0,45	1,40	0,20	0,22	0,69
Dromedary	2,98	1,00	0,85	0,40	0,20	0,44
Camelopard	4,22	1,82	0,88	0,35	0,24	0,93
Ox	2,12	0,39	0,58	0,35	0,20	0,60
Stag	1,50	0,47	0,46	0,30	0,12	0,15
Horſe	2,01	0,49	0,64	0,24	0,17	0,47
Dolphin	1,26	0,04	0,26	0,96		
Porpoiſe	1,10	0,03	0,25	0,82		

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* The Metre, which is the unit in this Table, is equal to 3 feet 11 lines of the old French meaſure, or about 3 feet 3 inches 6 lines Engliſh.—T.

3. *Form of the different Vertebræ in Mammiferous Animals.*

α *Vertebræ of the Neck.*

The cervical vertebræ of the genus *ſimia*, differs from ours only in their ſpinous proceſs being ſtronger, and not forked. Their bodies, too, preſs more upon each other anteriorly, which ſerves the better to ſupport the head.

In the *pongo*, in particular, their ſpinous proceſſes are exceſſively long, doubtleſs in conſequence of the largeneſs of the head and the length of the muzzle.

In the Carnivora, the tranſverſe proceſſes of the middle vertebræ of the neck aſſume a compreſſed ſhape, both on the anterior and poſterior ſurfaces. The two laſt only form grooves; the holes are almoſt in the body of the vertebræ; the axis and atlas are much larger; the tranſverſe proceſſes of the atlas are very large and flat on the front and the back; the ſpinous proceſs of the axis is very high, and is prolonged both upward, upon the atlas, and downward, upon the third vertebra: they thus furniſh ſufficient points of inſertion for the muſcles that move and ſupport the head, which is very diſadvantageouſly placed in theſe animals. The other ſpinous proceſſes, except the laſt, are ſhort: they are all directed, more or leſs, towards the head.

In the *moles* and in the *ſhrews* the vertebræ of the neck have no ſpinous proceſſes at all. They form ſimple rings, which admit much freedom of motion.

Among the Edentata, the *ant-eaters* and the *armadillos* have the ſix laſt cervical vertebræ ſoldered or oſſified together. The bodies of all theſe vertebræ are large, and compreſſed anteriorly. In all the ſpecies of this family they form a ſort of groove, in which the œſophagus is lodged.

The bodies of the vertebræ of the Rodentia, as well as thoſe of the *hog*, the *tapir*, and the *rhinoceros*, are diſpoſed in a manner nearly ſimilar. The tranſverſe proceſſes in the *hog* have the anterior part of their extremities ſo much enlarged and compreſſed that they ſeem double.

The *elephant*, whoſe neck is very ſhort, has vertebræ like thoſe of the Monkey tribe.

In the Ruminantia, the ſpinous proceſſes diminiſh in proportion to the length of the neck. In the *camel*, the *camelopard*, &c. theſe proceſſes are almoſt effaced, which is neceſſary, otherwiſe the neck could not be bent backward. The tranſverſe proceſſes are compreſſed, and form two angles, the ſuperior of which is directed forward, and the inferior towards the ſide. In thoſe which have ſhort necks, ſuch as the *ox*, the *goat*, and the *ſheep*, theſe two angles form double tranſverſe proceſſes.

The cervical vertebræ of the *horſe* have much reſemblance to thoſe of the Ruminantia. In both, the bodies of the vertebræ have a ſort of longitudinal ridge on their anterior part.

In quadrupeds, in general, the laſt but one of the cervical vertebræ has, upon the lateral parts of its body, two obtuſe eminences, which form a kind of channel.

In the *dolphin*, the atlas has a conſiderable reſemblance to that of *man*; the axis is very thin, and anchyloſed with the atlas. The other five vertebræ are nearly as thin as paper.

In the *cachalot* the whole ſeven vertebræ are anchyloſed; the five intermediate ones are extremely thin.

β *Vertebræ of the Back.*

The dorſal vertebræ of *monkeys* do not materially differ from thoſe of man. The ſpinous proceſſes in the *macacques* and *magots* are, however, elongated, and ſomewhat elevated.

The *bats* have no ſpinous proceſſes on their dorſal vertebra; they are replaced by very ſmall tubercles, and even theſe are wanting in ſome ſpecies, ſo that the ſpinal column preſents no aſperities on its poſterior part. Their vertebral canal has a very great diameter in this region.

In the true quadrupeds, theſe proceſſes are longer, ſtraighter, and ſtronger, in proportion as the head is heavy, or joined to a longer neck. It is neceſſary, indeed, that they ſhould afford to the cervical ligament points of attachment proportioned to the weight it has to ſupport; thus the *camelopard*, the *camel*, the *ox*, the *rhinoceros*, and the *elephant*, have theſe proceſſes longeſt. It is a miſtake to imagine that they ſuſtain the hunch of the camel, it being compoſed of fat only.

The *dolphin* has them of a moderate ſize, but ſtraight, and leſs than thoſe of the *lumbar vertebræ*, becauſe the latter furniſh inſertions to the vaſt muſcles of the tail.

γ *Vertebræ of the Loins.*

The lumbar vertebræ of *apes* have their ſpinous and tranſverſe proceſſes directed a little towards the head. This is ſtill more apparent in the *dog* and *cat*, in which theſe proceſſes are longer. In the Quadrumana and Sarcophaga there is commonly on the external ſide of each poſterior articular proceſs, a point directed backward, ſo that the anterior articular proceſs of the next vertebra is received between two prominences. The motion is thus conſiderably limited. This point likewiſe exiſts in the Rodentia, but it is generally ſhorter: no ſuch diſpoſition is found in the other orders. The magnitude of the tranſverſe proceſſes marks the ſtrength of the loins, as is obſervable in the *ox*, the *horſe*, the *porpoiſe*, &c.

δ *Vertebræ of the Sacrum.*

The os ſacrum of quadrupeds is in general narrower than in man, and forms with the ſpine one ſtraight line. It preſents therefore no ſolid baſe for an erect poſture, as we ſhall ſee more evidently in treating of the pelvis.

The form of the ſacrum is generally that of a long triangle. In every genus, thoſe ſpecies which ſometimes ſtand erect, have it proportionably larger than others; ſuch are, the *monkey*, the *bear*, and the *ſloth*.

The ſpinous proceſſes, which in man and the monkey are very ſhort, are ſomewhat longer in the carnivorous animals: they almoſt touch and form a continued creſt in the *rhinoceros*, and in moſt of the ruminating kind; but this diſpoſition is moſt remarkable in the *mole*, which has the creſt very long, as well as the bone itſelf.

In the *ternate bat*, the os ſacrum forms a long compreſſed point, the extremity of which unites with the tuberoſities of the os iſchium, but has no os coccygis.

The Vertebræ of the Tail.

The caudal vertebræ in mammalia are of two ſorts; thoſe that preſerve a canal for the paſſage of the ſpinal marrow, and thoſe that do not: the latter are generally of a priſmatic form; they diminiſh gradually in magnitude to the end of the tail; they have only ſlight protuberances for the inſertions of the muſcles.

The others are the neareſt to the ſacrum; they have articular and tranſverſe proceſſes, and alſo ſpinous proceſſes, which are the more diſtinct in proportion as theſe animals move the tail with greater frequency and force.

Thoſe animals in which the tail is prehenſile, as the *ſapajous*, have on the under ſide, and at the baſe of each body of the vertebræ, two little prominences between which the tendons of the flexor muſcles paſs.

The mammalia, in which the tail is long, and much accuſtomed to motion, have often two or three little ſupernumerary bones, ſituated at the inferior ſurface upon the joints of ſome of the vertebræ: theſe bones commonly extend from the third or fourth vertebræ, to the ſeventh or eighth: it has been obſerved that their ſhape reſembles a V; they afford points of inſertion for muſcles.

The *beaver*, which uſes his tail as a trowel, has the caudal vertebræ remarkable both for the magnitude of the tranſverſe proceſſes, and becauſe the inferior ſpinous proceſſes are larger than the ſuperior. To this he is indebted for the force with which he ſtrikes his tail downward when forming the earth into mortar.

The ſpine of the *cetacea* differs widely from that of quadrupeds in its form, which more nearly reſembles that of fiſhes: it may be uſeful, briefly to notice, in this place, its peculiarities.

Of the ſeven cervical vertebræ the firſt alone is quite diſtinct, and bears a well defined ſpinous proceſs.

The dorſal vertebræ have at firſt the articular proceſſes at the root of the tranſverſe; but towards the ninth vertebra there are only the ſuperior ones; for at this height theſe articular proceſſes turn backward to the baſis of the ſpinous proceſſes next the head, and form a kind of groove which receives the preceding ſpinous proceſs.

The vertebræ of the loins and tail admit of no diſtinction, as there is no pelvis. It may be obſerved, however, that the tranſverſe proceſſes, which are very long in the firſt lumbar vertebra, become ſhorter as they approach the tail, and are totally effaced in the laſt of thoſe vertebræ.

C. *In Birds.*

The number of the vertebræ that compoſe

the different regions of the ſpine, varies as much in birds as in quadrupeds. This will appear from the following Table;

TABLE of the Number of the Vertebræ in Birds.

SPECIES.	Ver. of the neck.	Ver. of the back.	Ver. of the ſacrum.	Ver. of the coccygis.
Vulture	15	7	1	7
Eagle	13	8	11	8
Bald-Buzzard	14	8	11	7
Sparrow-Hawk	11	8	11	8
Common Buzzard	11	7	10	8
Kite	12	8	11	8
Great Horned Owl	13	7	12	8
Common Owl	11	8	11	8
Fly-Catcher	10	8	10	8
Blackbird	11	8	10	7
Tanager	10	8	9	8
Crow	13	8	13	7
Magpie	13	8	13	8
Jay	12	7	11	8
Starling	10	8	10	9
Groſs-beak	10	7	12	7
Bull-finch	10	6	11	6
Sparrow	9	9	10	
Gold-finch	11	8	11	8
Titmouſe	11	8	11	7
Lark	11	9	10	7
Red-breaſt	10	8	10	8
Swallow	11	8	11	9
Goat-ſucker	11	8	11	8
Humming Bird	12	9	9	8
Hoopoe	12	7	10	7
King's-fiſher	12	7	8	7
Wood-pecker	12	8	10	9
Toucan	12	8	12	more than 7
Parrot	11	9	11	8
Pigeon	13	7	13	7
Peacock	14	7	12	8

SPECIES.	Ver. of the neck.	Ver. of the back.	Ver. of the ſacrum.	Ver. of the coccygis.
Pheaſant	13	7	15	5
Turkey	15	7	10	5
Curaſſow Bird	15	8	10	7
Oſtrich	18	8	20	9
Caſſowary	15	11	19	7
Flamingo	18	7	12	7
Heron	18	7	10	7
Stork	19	7	11	8
Crane	19	9	12	7
Spoonbill	17	7	14	8
Avoſet	14	9	10	8
Plover	15	8	10	7
Lapwing	14	8	10	7
Woodcock	18	7	13	8
Curlew	13	8	10	8
Oyſter-catcher	12	9	15	
Rail	13	8	13	8
Coot	15	9	7	8
Jacana	14	8	12?	7
Pelican	16	7	14	7
Cormorant	16	9	14	8
Sea ſwallow	14	8	10	8
Gull	12	8	11	8
Petrel	14	8	? ?	8
Swan	23	11	14	8
Gooſe	15	10	14	7
Barnacle	18	10	14	9
Duck	14	8	15	8
Sheldrake	16	11	11	9
Scoter, or Black Diver	15	9	14	7
Merganſer	15	8	13	7
Grebe	14	10	13	7

The vertebræ of the neck of birds, are in general very numerous; they vary from ten to twenty-three; the number of the dorſal vertebræ varies from ſeven to eleven. There are no lumbar vertebræ, properly ſo called; all thoſe which extend from the thorax to the tail being oſſified in one piece with the two oſſa ilii. The tail is ſhort, and has but a few joints; from ſeven to eleven.

The part which varies moſt in point of length is the neck: its length is proportioned to the height of the legs, except in ſome water-fowls, where it greatly exceeds that proportion. This is neceſſary to enable them to ſeek their food below the ſurface of the water in which they ſwim.

The bodies of the vertebræ of the neck are not articulated by flat ſurfaces, which only admit of an obſcure motion, but by ſurfaces forming portions of a cylinder, which allow great flexion. The three, four, or five uppermoſt vertebræ can only bend forward, and the reſt only backward. This makes the necks of birds reſemble the letter S; and it is by contracting or widening the two arches which form this curve, that they ſhorten and ſtretch out the neck.

The articular proceſſes of theſe vertebræ point upward and downward; the others forward and backward.

Inſtead of tranſverſe proceſs, the cervical vertebræ of birds have only an eminence upon the upper part. The anterior extremity is furniſhed with a ſtyloid proceſs, which deſcends parallel to the body of the vertebra.

The uppermoſt and lowermoſt, only, have diſtinct ſpinous proceſſes, and theſe have them both on the anterior and the poſterior part. The intermediate vertebræ have anteriorly two ridges, which form a ſemi-canal; and poſteriorly, a protuberance which is often bifid, and which, when prolonged, preſents two ſcabrous lines.

This ſtructure was neceſſary for lodging the tendons of the muſcles that produce the complicated motions we obſerve in the necks of birds.

The *atlas* is ſhaped like a little ring; it is only connected with the head by one ſurface.

The back of birds is as remarkable for its want of motion, as their neck is for its flexibility. The vertebræ which compoſe the back have ſpinous proceſſes, touching each other, and tied together by ſtrong ligaments. The greater part of theſe proceſſes are often united into a ſolid piece, which runs, like a ridge, along the whole length of the back. The tranſverſe proceſſes ſend off from their extremities two points; the one directed forward, the other backward: they join thoſe of the other vertebræ, and ſometimes are ſoldered to them in the ſame manner as the ſpinous proceſſes are to each other. This diſpoſition was neceſſary, that the trunk might remain firm amidſt the violent efforts which the motion of flying requires: indeed, the birds which do not fly, ſuch as the *oſtrich* and the *caſſowary*, retain the motion in their ſpine.

The laſt dorſal vertebræ are frequently placed under the criſta of the ilium, and there, like the lumbar vertebræ, they are often anchyloſed with the large bone of the haunches; on this account the number of holes which give paſſage to the nerves is commonly the only criterion of the number of theſe vertebræ.

The vertebræ of the tail are moſt numerous in thoſe birds that move it with the greateſt force, ſuch as the *magpie*, *ſwallow*, &c. They have ſpinous proceſſes both above and below, and very long tranſverſe proceſſes. The laſt of all (to which the quills are attached) is largeſt, and has the form of a ploughſhare, or a compreſſed diſque. In the *caſſowary*, which has no viſible tail, the laſt bone has a conical ſhape. In the *peacock*, on the contrary, it has the figure of an oval plate ſituated horizontally.

D. *In Reptiles.*

The number of vertebræ, and every other attribute of the ſpine, are more varied in this claſs of animals than in any other.

In the *tortoiſes* ſeven vertebræ are aſſigned to the neck; the firſt is only a ſimple tubercle, the annular portion of which is very diſtinct. The ſurface, by which it is articulated with the head, is formed of three planes, one anterior and two lateral. The point in which they unite is the moſt prominent, and to this is attached a ſtrong ligament. The ſurface which unites it to the next vertebræ is a glenoid cavity; the ſecond and the following vertebræ have a prominent longitudinal ridge upon the fore-part of their body. The articular proceſſes deſcend below the body; there are no ſpinous proceſſes except one to the ſecond vertebra, which points forward, and one to the third in the form of a ſimple tubercle. The two laſt vertebræ, at a certain age, become anchyloſed.

There are eight dorſal vertebræ, but they are all anchyloſed together with the ribs and the back ſhell in one immoveable piece. They have, therefore, neither proceſſes nor articular ſurfaces. They are all narrower in the middle than at the ends.

The lumbar and ſacral vertebræ are likewiſe conſolidated with the back ſhell, but thoſe of the tail are free and moveable.

The condyle, which forms the body of theſe vertebræ at its articulation with the others, inclines backward, and not towards the head, as thoſe of the neck do. There are likewiſe upon the fore-part of the body, at its baſe, two ſmall tubercles; but all the proceſſes of theſe vertebræ reſemble thoſe of the mammalia.

In the family of *lizards*, the *crocodile* has ſeven cervical vertebræ, the five laſt of which have their proceſſes ſo cloſely preſſed together that the neck cannot be bent towards the ſide. The ſame number (ſeven) is found in moſt lizards, though the *cameleon* has only two. The ſacral vertebræ are few in every ſpecies, and none of them have a large os ſacrum.

As *frogs* have no ribs, no diſtinction can be formed with reſpect to the three firſt orders of vertebræ in them.

They have, in general, eight between the neck and the pelvis, all furniſhed with pretty long tranſverſe proceſſes. The laſt are the longeſt, and touch the oſſa ilii. In the *toads* the tranſverſe proceſſes are very large, and ſhaped like hatchet blades. The os ſacrum conſiſts of a ſingle bone only; it is long, pointed, compreſſed, and has no coccyx. In the *pipa*, which has the tranſverſe proceſſes of the ſecond and third vertebræ much longer than the others, and almoſt like ribs; this bone is oſſified with the laſt vertebræ.

The *salamanders* have fourteen vertebræ between the head and the ſacrum; they have all nearly the ſame ſhape except the firſt, which receives the head, and the laſt, which is articulated to the ſacrum. The two extremes of the ſpine alone want the veſtiges of the ribs, which conſiſt of ſmall oblong moveable bones, actually articulated to the tranſverſe proceſſes, which here take a poſterior direction. The articular proceſſes are large, and wedged together. The poſterior reſt upon the anterior, ſo as to impede the motion of the ſpine backward. The ſacrum conſiſts only of a ſingle vertebra, but there are twenty-ſeven in the tail.

In *ſerpents*, the vertebræ alone conſtitute almoſt the whole ſkeleton, and they are nearly of the ſame form from the head to the tail: the body, as well as the ſpinous, articular, and tranſverſe proceſſes, are eaſily diſtinguiſhed. In certain kinds, for inſtance the *boa*, the ſpinous proceſſes, which are continued throughout the whole length of the back, are ſeparated from each other, and allow reciprocally a motion ſufficiently conſpicuous. Wherever this diſpoſition of the ſpinous proceſſes prevails, the body of the vertebræ, on the ſide next the belly, preſents only an obſcure projecting line.

In other kinds of ſerpents, as for example the *rattleſnake*, the ſpinous proceſſes are long, and ſo large as to touch each other. They have, for their baſis, the articular proceſſes, which lie on each other like tiles. In conſequence of this ſtructure, the motion of the ſpine towards the back is very circumſcribed, but its motion towards the belly and ſides much augmented. The bodies of the vertebræ play very eaſily in theſe directions upon one another, and are armed with a ſharp ſpine tending towards the tail, which only obſtructs their motion when it might produce a luxation.

The firſt vertebræ differ from thoſe of the reſt of the body, only in having the rudiments of the ribs much ſmaller: there is no neck in theſe animals.

The vertebræ of the tail differ no farther than in having no ribs, and that their ſpines, both ventral and dorſal, are double, or form two ranges of tubercles. The articulation of the bodies of the vertebræ with each other is very remarkable: the anterior part of the body of the vertebra preſents a ſmooth hemispherical tubercle, and the poſterior part a correſponding cavity; ſo that each vertebra becomes connected to thoſe next it by a ſort of knee joint: this mode of articulation fully explains the motion of reptiles, which is performed winding from ſide to ſide, and not up and down, as it is repreſented by painters.

TABLE of the Number of the Vertebræ in Reptiles.

1. *Oviparous Quadrupeds.*

SPECIES.	Ver. of the neck	Ver. of the back.	Ver. of the loins.	V. of the ſacrum.	Ver. of the tail.
Turtle	8	11	0	3	20
Crocodile	8	11	5	2	36
Tupinambis	7	18	4	2	104
Iguana	5	11	9	2	72
Cameleon	3	17	3	1	69
Salamander	1	12	1	1	26
Frog	10 in all				
Pipa, or Surinam toad	8 in all				

2. *Serpents.*

SPECIES.	Vertebræ to which ribs are joined.	Vertebræ of the tail.
Viper (berus)	139	55
Spectacle Snake (naia)	192	63
Garter Snake (natrix)	204	112
Amphiſbæna.	54	7
Boa (conſtrictor)	252	52
Common Snake	244	more than 60
Rattleſnake.	175	26
Slow-worm (anguis fragilis)	32	17

E. *In Fishes.*

The vertebræ of oſſeous fiſhes have their bodies ſometimes cylindrical, ſometimes angular, and ſometimes compreſſed. They are joined by their bodies only. The annular portions do not touch each other, and they have no articular proceſſes: they may be divided into two claſſes, the *caudal*, which have a ſpinous proceſs above and another below; and the *abdominal* or *dorſal*, which have the ſpinous proceſs upon the upper part only. Theſe laſt have generally, on the ſides, tranſverſe proceſſes, to which the ribs are attached.

The ſpinous proceſſes both inferior and ſuperior are very long, particularly in thoſe which are flat, as the *pleuronectes*, *chætodons*, &c. The canal for the paſſage of the ſpinal marrow is formed in the vacancy of the ſuperior proceſſes. In the inferior there is a ſimilar paſſage for the blood veſſels. The ſtructure of cartilaginous fiſhes is nearly ſimilar; but as all the cartilages are

con-

conſolidated together, the ſpinous proceſſes can only be diſtinguiſhed.

The vertebra of a fiſh may be eaſily known from that of any other animal, by the configuration of its body, which preſents, both anteriorly and poſteriorly, cavities that are united to ſimilar depreſſions in the adjoining vertebra, and form, throughout the whole vertebral column, cavities compoſed of two cones joined at the baſe. Theſe hollow cones contain a cartilaginous ſubſtance, formed of concentric fibres, of which thoſe next the centre are much the ſofteſt. Upon this cartilage all the vertebræ perform their motions.

The laſt vertebra of the tail is, for the moſt part, of a triangular form, flat, and placed vertically; upon its poſterior extremity it bears articular impreſſions, which correſpond to the ſmall and delicate bones of the fin of the tail. Beſides the hard parts which ſupport the bodies of fiſhes, there are certain ſmall bones quite detached and unarticulated, which ſerve as fulcra to the muſcles of the body. There are others which take the ſame direction as the ſpinous proceſſes, and ſupport the dorſal and anal fins. Theſe laſt vary much in their form in the different kinds of fiſh; ſometimes they are triangular, and ſometimes compreſſed, rounded, or ſerrated, on one or more of their angles. The little bones are retained in their poſitions by a ligament which connects them to the proceſſes of the vertebræ. Each ſupports one or more of the radii of the fins.

TABLE of the Number of the Vertebræ of Fiſhes.

SPECIES.	Cervical vertebræ	Dorſal vertebræ;	Lumbar verteb.	Caudal vertebræ.
Ray	offified into one piece.	4		more than 80
Shark	207 in all			
Sturgeon	28 in all			
Syngnathus acus	more than 50 in all			
Syngnathus Hippocampus	62 in all			
Baliſtes		7		10
Oſtracion quadricornis	13 in all			
Eel	115 in all			
Sea Wolfe	2	24		50
Sea Dragon	2	13		30
Uranoſcope	1	9		15
Whiting	2	17	4	32
Sea Scorpion		8	2	15
Armed Trigla		12		23
Red Gurnard		13		21
Small flying Trigla	3	8		12
Remora		12		15
Plaice		13		30
Stickleback		17		22
Perch		21		20
Dorée	4	9	2	16
Zeus Vomer		10		13
Horned Chætodon		9		12
Stripped Chætodon		9		12
Carp	1	15	9	16
Cyprinus Naſus	1	19	5	19
Herring	4	38		18
Rhomboid Salmon (Salmo Rhombeus)	1	12		20
Pike (Lucius)	4	35		20
Brazilian Pike		34	3	15

SPECIES.	Cervical vertebra.	Dorſal vertebræ.	Lumbar vertebra.	Coudal vertebræ.
Silurus Felis	1	12	1	30
Armour-fiſh (Loricaria)	1	6	1	28
Tobacco-pipe-fiſh (Fiſtularia Tobacaria)		59		22

ARTICLE II.

Of the Muſcles of the Spine.

A. *In Man.*

IN the lumbar and dorſal region of the human ſpine, the motion of each vertebra upon thoſe next to it is very obſcure: the total power of flexion is, however, conſiderable. In the cervical region, the motion is greater, and conſidered as a whole; the vertebral column is capable to a certain degree of being turned round.

The muſcles of the ſpine are numerous and complicated; poſteriorly there are:—

1. THE INTERSPINALES.

Theſe muſcles are diſpoſed in two rows between the ſpinous proceſſes of all the vertebræ: there are twenty-three on each; they ſerve to bend the ſpine backward.

2. THE INTERTRANSVERSALES,

Which have nearly the ſame ſhape as the preceding: theſe are ſituated between the tranſverſe proceſſes; when the muſcles of one ſide only act, they bend the ſpine towards that ſide; when thoſe of each ſide act together, they maintain the ſpine in an erect poſition.

3. THE TRANSVERSO-SPINALES.

Theſe muſcles extend obliquely from the inferior tranſverſe proceſſes, and from the tubercles of the ſacrum to the ſuperior ſpinous proceſſes. They form a compact maſs, which covers the whole ſpine; and is called *tranſverſo-ſpinalis magnus*, or *multifidus ſpinæ*.

4. THE SPINALIS COLLI

Is attached to the ſpinous proceſſes of the cervical vertebræ from the ſecond to the ſixth; the ſuperior ſlips covering the inferior. Below it is attached to the tranſverſe proceſſes of the ſeven firſt dorſal vertebræ by diſtinct tendinous ſlips.

5. THE SEMISPINALIS DORSI.

This muſcle is ſituated tranſverſely upon the ſpine, and lower than the preceding. It is inſerted into the ſpinous proceſſes of the two laſt cervical, and the five firſt dorſal vertebræ, and ariſes from the tranſverſe proceſſes of the ſeventh, eighth, ninth, and tenth vertebræ of the back.

6. THE SPINALIS DORSI.

This muſcle is alſo ſituated tranſverſely, but partly higher and partly lower than the preceding. It is formed of concentric bundles of fibres. The ſuperior part is inſerted into the ſpinous proceſſes of the dorſal vertebræ from the ſecond to the eighth. The inferior part is attached to the ſpinous proceſſes of the three loweſt dorſal, and the two firſt lumbar vertebræ.

7. THE LONGISSIMUS DORSI

Is more ſuperficial, and is placed above the preceding muſcles: the direction of its fibres is, however, the reverſe of theirs. It is connected by a ſtrong tendon to the os ſacrum, and is alſo attached to all the ſpinous proceſſes of the lumbar vertebræ: hence it aſcends to the ſeventh vertebra of the neck. In its paſſage it affixes itſelf by ſeparate portions internally to the tranſverſe proceſſes of all the dorſal vertebræ, and externally to the eight loweſt ribs.

8. THE TRANSVERSALIS COLLI, *or* TRANSVERSALIS MAGNUS,

pper part of Is between the longiſſimus dorſi and the preceding muſcles. It extends from five or ſix of the firſt proceſſes of the dorſal vertebræ, to the third, fourth and fifth tranſverſe proceſſes of the vertebræ of the neck. It is conſidered as an acceſſory to the longiſſimus dorſi.

9. THE SACROLUMBALIS

Is ſituated more externally, and riſes along with the *longiſſimus dorſi*, with which it is confounded at the inferior part. The ſuperior part is inſerted into the angles of all the ribs, and the tranſverſe proceſs of the laſt vertebra of the neck by an equal number of tendinous ſlips.

10. CERVICALIS DESCENDENS, *or* TRANSVERSALIS TENUIS.

This muſcle is placed between the *longiſſimus dorſi* and the *ſacro-lumbalis*. It is attached at the upper part to the tranſverſe proceſſes of all the cervical vertebræ after the third, and is inſerted by tendinous ſlips, which croſs the tendon of the ſacro-lumbalis into the angles of all the ribs. This muſcle is an auxiliary of the *ſacro-lumbalis*.

To form a clear idea of the action of the different muſcles of the ſpine, they ſhould be conſidered together.

The maſs of fleſhy and aponeurotic fibres which occupies the poſterior part of the ſpine, and ſeems to ariſe from the os ſacrum, may be looked upon as a ſingle muſcle, and called SACRO-SPINALIS. It is compoſed of three principal branches.

The firſt, which is the moſt internal, and next to the ſpinous proceſſes, correſponds to the *ſpinalis colli* and *ſpinalis dorſi*. It keeps the ſpine ſtraight, and draws it backward when it has been inclined forward.

The ſecond portion, which is external, forms what anatomiſts have named the *ſacro-lumbalis*, and its acceſſary the *cervicalis deſcendens*. It acts like the preceding.

The third portion is intermediate; it is formed by the *longiſſimus dorſi* and its acceſſary, or *tranſverſalis magnus colli*, and has preciſely the ſame uſe as the two others.

We next obſerve the ſmall muſcles ſituated between each pair of vertebræ: theſe form three ſeries.

1. *The Tranſverſoſpinales.*
2. *The Interſpinales.*
3. *The Intertranſverſales.*

There is only one muſcle ſituated upon the anterior part of the ſpine, which acts excluſively upon it: this is called

LONGUS COLLI, *or* PRÆ-DORSO-ATLOIDEUS.

It is attached to the three firſt dorſal vertebræ, and to the anterior tubercle of the atlas; it bends the neck forward.

The vertebræ of the tail or coccyx are capable of a ſmall degree of motion backward and forward, which is performed by means of two pair of muſcles, named,

1. THE ISCHIO-COCCYGEUS, *or* ISCHIO-CAUDALIS,

Is attached to the ſpine of the os-iſchium and the lateral parts of the bones of the coccyx. When both muſcles act, they pull the bones ſomewhat backward.

2. THE SACRO-COCCYGEUS, *or* SACRO-CAUDALIS.

It comes from the internal ſurface of the os ſacrum; and it is inſerted into the internal ſurface of the os-coccygis, which it elevates by its contraction.

B. *In other Mammiferous Animals.*

The muſcles of the ſpine of *monkeys* nearly reſemble thoſe of man; they differ only with reſpect to the ſtrength of the tendons.

Thoſe of the *bat* are ſo thin, that a few tendinous fibres alone are perceivable on the part near the ſpine.

The other mammalia differ only in the number of attachments, which depends upon that of the vertebræ. In the *hog*, for inſtance, the *ſpinalis dorſi* ariſes diſtinctly from the firſt ſpinous proceſs of the back by a fleſhy ſlip: ſimilar portions come from each ſucceeding ſpinous proceſs, and they all unite to tendons which are inſerted into the ſpinous proceſſes of each lumbar vertebra.

The motions of the tail are much more viſible in the reſt of the mammalia than in man. It is an additional member granted to them by nature, ſince many of them uſe it to faſten themſelves to trees, or to ſuſpend themſelves from them. The greateſt part uſe it as a whip to drive away paraſitical inſects; others, as the *cetacea*, direct their courſe in the water by its motion. The *beaver* employs it as a trowel to build his habitation, &c. It is evident, therefore, that, to execute theſe various operations, more muſcles are required in theſe animals than in man.

The tail of mammiferous animals is ſuſceptible of three ſorts of motion: one by which it is turned backward, or raiſed up; another, by which it is inflected, or lowered; and a third, by which it is directed towards the ſides.

The combination of theſe motions produce others of a ſecondary kind: thus the tail may be turned upon its own axis, or rolled into a ſpiral form in the ſame plane, or like a ſcrew, as in thoſe animals which have it prehenſile.

Theſe motions are effected by three claſſes of muſcles very different from thoſe of the human body, as we ſhall preſently ſee.

a. *The Muſcles that raiſe or throw back the Tail.*

Theſe are always ſituated on the ſuperior or ſpinal ſurface.

1. THE SACRO-COCCYGEI SUPERIORES, *or* LUMBO-SUPRA-CAUD~~U~~ALES.

Theſe ariſe from the articular proceſſes of the three or four laſt vertebræ of the loins, thoſe of the ſacrum, and from ſuch of the vertebræ of the tail as have proceſſes by fleſhy ſlips, which gradually diminiſh in their thickneſs. Small tendons proceed from the common maſs oppoſite to the fleſhy digitations. The firſt tendon is the ſhorteſt; it proceeds from the internal ſide, and is inſerted into the baſe of the firſt of the caudal vertebræ, which have no articular proceſſes. The ſecond tendon proceeds to the next, and ſo on to the end. There are generally thirteen of theſe tendons; they enter a ligamentous groove, which ſerves as a ſheath to them; all theſe ſheaths are joined together by a ligamentous plexus, which encloſes them as it were in a kind of caſe.

When theſe two muſcles act together, they raiſe the tail, or reflect it upwards.

2. INTER-

2. INTERSPINALES, SPINALIS OBLIQUUS, *or* LUMBO-SACRO-COCCYGEUS *of Vicq. D'Azyr.*

Theſe muſcles are the continuation of the *interſpinales* of the trunk; but as the ſpinous proceſſes of the tail are ſhort, and often replaced by two tubercles which anſwer to the oblique proceſſes, the inſertions are ſomewhat different. This, perhaps, is the reaſon why thoſe muſcles have been regarded as diſtinct by many anatomiſts.

b. *The Muſcles which depreſs or bend the Tail downward.*

Theſe ariſe within the pelvis, and extend more or leſs along the inferior ſurface of the tail. They conſiſt of four pair.

1. THE ILEO-SUBCAUDALIS, *or* ILEO-COCCYGEUS *of Vicq. D'Azyr.*

This muſcle ariſes from the internal part of the os ilium, forms a long fleſhy maſs within the pelvis, and is inſerted into one of the bones ſhaped like a V, which are ſituated under the tail; ſometimes, as in the *racoon*, the inſertion takes place between the fifth and ſixth bone; and ſometimes between the ſeventh and eighth, as in the *opoſſum*: This muſcle depreſſes the tail, and applies it cloſe to the anus.

2. THE

2. THE SACRO-SUBCAUDALIS, *or* SACRO-COCCYGEUS INFERIOR *of Vicq. D'Azyr.*

This muſcle is the antagoniſt of the *ſacro-coccygeus* or *lumbo-ſupra-caudalis*, which it exactly reſembles in ſtructure. It ariſes from the inferior part of the os ſacrum, and the tranſverſe proceſſes of ſuch of the caudal vertebræ as poſſeſs thoſe proceſſes by a fleſhy portion, which becomes gradually ſmaller, and forms as many tendons as there are caudal vertebræ unfurniſhed with tranſverſe proceſſes: Theſe tendons are received into a ſheath like thoſe of the lumbo-ſupra-caudalis, and are inſerted into the baſe of each of the vertebræ on the under ſide, beginning uſually at the ſeventh.

3. THE SUB-CAUDALES, *or* INTER-COCCYGEI *of Vicq. D'Azyr.*

Theſe are ſituated under the inferior middle line of the tail. They ariſe at the articulation of the firſt and ſecond caudal vertebræ, and form an elongated portion, which is firſt inſerted into the V ſhaped bone of the fourth, fifth, and ſixth vertebræ. They likewiſe receive little fleſhy ſlips, which gradually diminiſh in thickneſs and, go on to be inſerted into the inferior ſurface of the baſe of each bone of the tail.

4. THE PUBO-SUB-CAUDALIS, *or* PUBO-COCCYGEUS *of Vicq. D'Azyr.*

This muſcle is wanting in the *racoon*, but is very diſtinct in the dog and opoſſum. It is thin, and ariſes fleſhy and expanded from the upper part of the pelvis, from whence it proceeds to terminate in a point, and is affixed under the tail to the proceſſes or tubercle at the baſe of the fourth and fifth vertebræ. Its action is the ſame as that of the Ileo-ſub-caudalis.

c. *The Muſcles which bend the Tail ſideways.*

Theſe are only two, *viz.*

1. THE ISCHIO-CAUDALIS, *or* ISCHIO-COCCYGEUS-EXTERNUS *of Vicq. D'Azyr,*

Ariſes from the internal ſurface of the os iſchium, below and behind the cotyloid cavity, and paſſes backward over the tranſverſe proceſſes of the vertebræ of the tail.

In the *dog*, it is only a fleſhy ſlip, which is inſerted into the fourth vertebra.

In the *racoon*, which wants the *pubo-ſub-caudalis*, it is inſerted into the ſeven vertebræ of the tail that follow the third by an equal number of fleſhy digitations.

In the *opoſſum* it terminates upon the four firſt vertebræ of the tail.

2. THE INTERTRANSVERSALES.

Theſe muſcles extend as a ſingle band, partly muſcular, partly aponeurotic, between all the tranſverſe proceſſes. Their tendons are moſt viſible on the upper part of the tail.

It appears, from the above enumeration, that there are eight pair of muſcles belonging to the tail.

C. *In Birds.*

Birds have no muſcles for the dorſal part of the ſpine. The neck only is moveable. It is furniſhed with a number of muſcles, which are—

The *intertranſverſales*; theſe are diſpoſed nearly in the ſame manner as in the mammiferous animals.

The *tranſverſo-ſpinales*, which proceed obliquely from the transverſe proceſſes of each inferior vertebra, to the ſpinal proceſs of its immediate ſuperior; but on that ſide only towards which the vertebra moves. Thus the upper vertebræ have them only on the anterior, and the lower ones only on the poſterior ſide.

There is alſo a muſcle analogous to the *cervicalis deſcendens*, or *ſacro-lumbalis*.

This muſcle ariſes from the ſpinous proceſſes of the back, and is inſerted by a very long tendon into the tranſverſe proceſs of the ſecond vertebra. It detaches five or ſix ſlips according to the different ſpecies, which are inſerted into the inferior tranſverſe proceſſes of the neck. Each of theſe at its inſertion receives two or three little bundles of muſcular fibres from as many of the inferior ſpinous proceſſes.

In the *buzzard*, for inſtance, the tendon inſerted into the ſecond vertebra receives five ſlips from the ſpinous proceſſes of the five vertebræ next to the third: the ſecond tendon, which is inſerted into the tranſverſe proceſs of the fifth vertebra, receives three faſciculi from the ſpinous proceſſes of the three following cervical vertebræ. In like manner, the third tendon, which is inſerted into the ſixth tranſverſe proceſs, receives four faſciculi from the ſpines of the cervical vertebræ, from the ſeventh to the tenth, and ſo on; but different numbers occur in the different ſpecies. All the ſmall auxiliary ſlips are ſituated between the two grand *cervicalis deſcendentes.*

The *longus colli* is a very complicated muſcle in birds: each ſtyle of the tranſverſe proceſſes of the vertebræ that admit of motion backward, receives a tendon from it, and this tendon, as it deſcends, receives muſcular faſciculi from ſeveral of the ſubjacent vertebræ.

In the *buzzard*, which we ſhall again take as an example, the tendons of the ſuperior ſtyles receive their faſciculi from the vertebra above them.

In the *heron*, the tendons of the ſuperior ſtyles have their fleſhy part or bellies attached to the loweſt of the vertebræ, and partly enveloping the tendons of the inferior ſtyles. We muſt, however, except thoſe of the three laſt cervical vertebræ, which are the ſame as in the *buzzard*.

The muſcles of the tails of birds are very diſtinct, and eaſily diſſected; ſome are employed in raiſing or lowering the tail; others in turning it towards the ſide.

The muſcles which elevate the tail are only two in number, one for each ſide.

THE SACRO-SUPRA-CAUDALES, *or* LEVATORES COCCYGIS *of Vicq. D'Azyr*,

Ariſe from the poſterior and ſuperior part of the pelvis and ſacrum, and extend to the external ſurface of the tranſverſe proceſſes of the vertebræ of the tail, by tendinous slips: theſe deſcend obliquely to the ſuperior ſpinous proceſs of the ſame vertebræ, and to the laſt bone of the tail, into which they are inſerted. When only one of theſe muſcles acts, it not only raiſes the tail, but alſo directs it to one ſide.

The muſcles employed in depreſſing the tail form likewiſe only one pair. They are

THE SACRO-SUB-CAUDALES, *or* DEPRESSORES COCCYGIS *of Vicq. D'Azyr*.

Theſe are ſituated within the pelvis, and their form is pyramidal. They ariſe from the poſterior depreſſions of the ilium and the point of the ſacrum. They alſo ariſe in part from the tranſverſe proceſſes of the firſt vertebræ of the tail, and are inſerted by tendinous ſlips into the ſpinous proceſſes of the ſame vertebræ, and into the rhomboidal proceſs of the laſt bone that ſupports the quills. They act preciſely like the preceding muſcles, but in the oppoſite direction.

The lateral flexors of the tail are all removed from the middle line. There are four of them on each ſide.

The firſt, which is alſo the longeſt, is

THE FEMORO-CAUDALIS, *or* CRURO-COCCYGEUS *of Vicq. D'Azyr.*

It ariſes from the femur, to which it is attached towards the uppermoſt third of its poſterior ſurface, and is inſerted into the ſuperior ſide of the rhomboidal proceſs of the laſt bone of the tail. It directs the tail towards the ſide when it acts ſeparately: when both muſcles act at the ſame time, the tail is bent downward, or lowered. That powerful inflexion of the tail which takes place when birds run, is to be attributed to the operation of this muſcle.

The ſecond of theſe muſcles is partly inſerted into the ligament which faſtens the external quill of the tail to the laſt bone, and it ariſes from the poſterior edge of the branch of the os pubis: when both muſcles act together, they ſpread out the feathers in the form of a fan, and enable the *peacock*, the *turkey*, and the *pheaſant*, to diſplay the variegated plumage of their tails.

The third is nearly parallel to the preceding, and ſituated on its internal ſide: it alſo takes its origin from the pubis, but ſomewhat towards the branch of the iſchium; it is inſerted into the lateral angle of the rhomboidal proceſs, ſituated, as we have already ſtated, beneath the laſt bone of the tail.

The fourth muſcle is the ſhorteſt of all. It is

THE MOTOR LATERALIS COCCYGIS
of Vicq. D'Azyr.

It ariſes from the external point of the ſpinous proceſs of the four vertebræ of the tail, which follow the firſt, and is inſerted into the lateral edge of the ligament which unites the quills of the tail: it ſpreads the quills, but with leſs force than the ſecond, to which it may be conſidered an acceſſary muſcle.

D. *In Reptiles.*

There are few ſpinal muſcles in *frogs.*

The muſcle which is analogous to the iſchio-coccygeus is large and thin, and occupies all the ſpace compriſed between the long bone of the coccyx and the ilea. Its fibres are oblique, and it ſerves to draw the coccyx into the direction of the ſpine.

That which is analogous to the *lumbo-coſtalis*, ariſes above the laſt by a ſort of point attached to the coccyx. It extends quite to the head, into which it is inſerted, and detaches fibres in its progreſs to each of the tranſverſe proceſſes, which form a kind of interſection upon its ſurface.

The *obliquus ſuperior* ariſes from the head at the margin of the foramen magnum, and is inſerted into the tranſverſe proceſſes of the firſt dorſal vertebra.

There is only one ſmall *rectus anterior*.

It ariſes from the baſe of the cranium, below the foramen magnum, and is inſerted into the firſt of the tranſverſe proceſſes.

The *intertranſverſales* are like the human.

The ſpinal muſcles of the *ſalamander* much reſemble thoſe of the *frog*. Thoſe of the tail are very ſimilar to the muſcles of *fiſhes*.

The ſpine of the *tortoiſe* has no motion except in the parts belonging to the neck and tail. Thoſe of the back and loins, which are oſſified together, have no muſcles.

The muſcles of the neck are very different from thoſe of man. The motions they produce are thoſe of elongation, by which the head is

protruded

protruded from the ſhell; and thoſe of retraction, by which it is withdrawn, the neck being bent in the form of a Z.

The firſt of the muſcles proper to the neck is attached to the under part of the anterior lateral border of the back ſhell, and into the tranſverſe proceſs of the firſt vertebra; it raiſes the neck and draws it back.

Another proceeds from the anterior and middle part of the ſhell: it is inſerted by four fleſhy ſlips, which are ſeparate throughout a conſiderable portion of their extent, into the articular proceſſes of the third, fourth, fifth and ſixth vertebræ of the neck. It draws the neck back when the head is much extended, and puſhes it out when it is retracted.

A muſcle alſo ariſes from the articular proceſſes of the third, fourth and fifth vertebræ of the neck, by three fleſhy portions, that afterwards unite, and terminate in two tendons; one of which is inſerted into the tranſverſe proceſs of the firſt, and the other into the ſpinous proceſs of the ſecond vertebra. This muſcle bends the neck upon itſelf, making it deſcribe a curve, which is convex downwards; this motion brings the head under the ſhell.

A muſcle analogous to the *longus colli*, ariſes from the under part of the body of the ſecond dorſal vertebra, beneath the ſhell; it aſcends along the neck, and furniſhes aponeurotic ſlips to all the tranſverſe proceſſes, as far as the ſecond vertebra, where it is inſerted. This alſo is one of the retractors of the head.

There are very diſtinct *interarticulares*, which, by their action, elevate each of the vertebræ, and conſequently extend the neck.

The *tranſverſo-ſpinalis* is ſituated on the poſterior part of the neck: It ariſes from all the ſuperior tranſverſe proceſſes, and is inſerted into all the ſpinous proceſſes, as far as the ſixth.

Finally, a ſhort muſcle proceeds from the upper part of the firſt dorſal vertebra below the ſhell, and is inſerted into the articular proceſſes of the ſixth and ſeventh cervical vertebræ. This muſcle is peculiar to the *tortoiſe*, and begins the extenſion of the neck when the head is concealed within the ſhell.

E. *In Fiſhes.*

The muſcles of the ſpine in fiſhes are very different from thoſe of other red-blooded animals; their ſituation and actions are totally changed.

In mammalia, in birds, and in reptiles, theſe muſcles are ſituated before or behind the vertebræ. In fiſhes, on the contrary, they are placed upon the ſide. From this difference of poſition reſults that of the motion produced; in the former, the vertebral column principally bends forwards, or erects itſelf, and the motion to either ſide is leſs ſenſible; but the lateral movement is much more remarkable in fiſhes, as in them it produces the action of ſwimming, while the motion of the ſpine towards the belly and the back ſcarcely exiſts.

The fleſhy fibres which determine the motion of the vertebral column, are interwoven in ſuch a manner that they are hardly to be diſtinguiſhed unleſs as layers, and in this manner we ſhall proceed to conſider them.

When the ſcales and ſkin are removed, we find underneath a fleſhy maſs compoſed,

1. Of fibres collected into little bundles, longitudinal and parallel, diſpoſed in arches with the convexity towards the head. All theſe arches are received one into another, and the interſecting line which diſtinguiſhes them ſeems the production of an aponeuroſis, in the ſubſtance of which are often found ſpines, or little flexible oſſified parts. This is eaſily obſerved in the *carp*, the *pike*, the *whiting*, &c.

2. Of other muſcular fibres, which, proceeding from the back and the belly, have a different courſe, and unite at the extremities of theſe arches. The ſuperior, or dorſal, take two directions, forming a V, or angle, open towards the head. Their ſurface furniſhes aponeurotic filaments, which terminate in ſmall tendons; they are inſerted and loſt in the ſkin.

The inferior or coſtal layer of fibres is compoſed of little intercoſtal muſcles, the length of each of which is equal to the reſpective diſtance of each rib, or inferior ſpinous proceſs.

Theſe three layers of fibres are ſo connected together, that they can only be conſidered as one and the ſame muſcle, attached to the bodies and proceſſes of all the vertebræ, and to the head. It has received the name of

MUSCULUS LATERALIS.

It produces all the lateral motions of the body, and more eſpecially thoſe of the tail. The manner in which it acts is eaſily explained: the contraction of the fibres of one ſide of the body cauſes the tail to approach the head in the ſame direction. When the tail is in this ſtate of lateral flexion, it can only be reſtored to its natural poſition by the contraction of the fibres of the oppoſite ſide; but when this contraction carries the tail beyond a right line, a motion oppoſite to the firſt is produced. It is by the repetition of theſe lateral and alternate motions that the action of ſwimming, or the progreſſion proper to fiſh, is performed.

The *oſtracions*, the bodies of which, with the exception of the jaws and members, are incloſed in a horney caſe nearly as hard as bone, have the lateral muſcles ſomewhat different. They are found under the parietes of the ſkin. They are nearly of equal magnitude, but they are attached to the head and tail only. Inſertions into the vertebræ of the body would have been uſeleſs, ſince only the part of the tail which is ſituated without the caſe is capable of motion. The texture of theſe lateral muſcles is alſo much more ſimple, as almoſt all their fibres are longitudinal.

As the ribs and muſcles are wanting, there is ſubſtituted for thoſe parts an aponeuroſis of a brilliant ſilver colour, which conſtitutes the integuments of the abdomen, and lines the internal ſurface of the caſe.

The tail of theſe fiſhes has a pair of muſcles peculiar to it, and ſeemingly aſſiſtant to the lateral. Their form is pyramidal; they are placed in the abdominal or inferior part of the body, and extend from about its middle to that part of the tail which is without the caſe. They ariſe from the inner ſurface of the ventral parietes of the caſe, and are inſerted by ſmall tendons into the inferior part of the ſides of the three laſt vertebræ of the tail, which they ſomewhat depreſs at the ſame time that they move it to one ſide.

In the interval which is left between the two lateral muſcles of the body in fiſhes, and towards the dorſal ridge, there appear ſome long and thin muſcles; their number is various, as it depends upon the exiſtence or number of the back fins. They are called *muſcúli dorſales*.

There is only one pair in thoſe that have no dorſal fin, as in ſome ſpecies of the *gymnotus*. They proceed from the neck, and terminate in the caudal fin. They are compoſed of ſmall and very ſhort fleſhy bellies, with long tendinous interſections.

In thoſe fiſhes that have only a ſingle dorſal fin, ſuch as the *loaches*, *carp*, *tench*, &c. there are two pairs of theſe muſcles; the firſt between the back of the neck and the dorſal fin, and the other between that fin and the caudal fin.

When there are two dorſal fins, as in the *mullet*, *zeus*, &c, we meet with three pairs of muſcles, one between the neck and the firſt fin, another between the two fins, and the third between the ſecond dorſal fin and the caudal fin.

All theſe muſcles are inſerted into the firſt rays of each of the fins, which they move by raiſing or unfolding them. There are muſcles perfectly analogous to theſe under the ridge of the belly.

In the *carp*, for example, there are two pairs; the one ariſes from the ſymphyſis of thoſe bones of a girdle form which receive the pectoral fins, and is inſerted on each ſide into the ligamentous tiſſue which unites the two ventral fins. The little fleſhy bellies of which this pair is compoſed, are four or five in number: they are placed at a diſtance from each other, and reſemble beads.

The other pair extends from the junction of the anal fins to the firſt rays of the caudal fin. Their fleſhy bellies are ſtill thinner, and the tendons much longer than thoſe of the former.

The fins of the back, belly, anus and tail, have little muſcles peculiar to themſelves, appropriated to fold and unfold them.

The direction and attachments of the little muſcles of the caudal fin are various. The longeſt uſually ariſe from the three vertebræ preceding the laſt of the tail: they are the outermoſt, and are inſerted into the five or ſix external, or longeſt rays on each ſide.

Others ariſe from the two laſt vertebræ: they ſpread, like the preceding, in the manner of a fan, and are inſerted into the intermediate rays.

Finally, there are, at the baſis of the rays themſelves, two muſcles with ſhort oblique fibres, which are inſerted into each of the rays by an equal number of digitations. Theſe are deſigned to compreſs the fin, while the former ſerve to open or unfold it.

The muſcles of the dorſal fins are diſpoſed nearly in the ſame manner; thoſe that extend them ariſe from the ſpinous proceſſes of the dorſal vertebræ; thoſe that bend them are ſhort, and ſtretched obliquely acroſs the little bones or rays that compoſe theſe fins.

The extenſor muſcles of the anal fin ariſe from certain particular ſpinous proceſſes on the abdominal ſurface of the vertebræ: the flexors are ſhort, and ſituated at the baſe of the rays.

We ſhall finiſh this article on the muſcles of the ſpine of fiſhes by a particular explanation of thoſe of the *ray*.

The ſpinal muſcles in this fiſh approach nearly to the form of thoſe which we have already deſcribed in the tails of certain quadrupeds.

They are diſpoſed in two layers, and are four in number; two *laterales ſuperiores*, and two *laterales inferiores*.

The *laterales ſuperiores* ariſe from the middle of the vertebral column above the abdomen, by a fleſhy head covered with ſtrong aponeuroſes: this portion extends as far as the pelvis, and there detaches little tendinous branches which paſs through parallel ſheaths, and proceed ſucceſſively towards the middle line, where they are inſerted into the upper part of each of the vertebræ of the tail. Fleſhy fibres accompany theſe tendons to ſome diſtance after their ſeparation from the common faſciculus.

In the inferior part of the tail the ſuperior lateral muſcles receive acceſſaries from each ſide; but theſe are ſimple tendons, which ſeem only intended to guard againſt too violent an extenſion either to one ſide or the other.

Each tendon of the lateral muſcles pulls that vertebra of the tail into which it is inſerted in the direction of its own action, and the flexion or general curvature of the tail upwards is the reſult of their common contraction.

The *laterales inferiores* of the tail ariſe alſo from the lumbar vertebræ like the preceding, but more externally. Their arrangement is nearly the ſame, with this difference, that their tendons make a kind of turn, and run under the tail, where they are inſerted into each of the vertebræ. They alſo receive tendinous acceſſaries, and produce motions in a direction oppoſite to the former, that is to ſay, they bend the tail downward: their tendons are more ſlender than thoſe of the ſuperior laterales; they divide into two branches at their extremities, and each bifurcation affords a paſſage for that of the next vertebra, ſo that they mutually ſerve as ſheaths, and are all, except the laſt, both perforating and perforated.

ARTICLE III.

Of the Ribs and Sternum.

A. *In Man.*

THE human thorax is ſhaped like a compreſſed cone, with the baſe downward, and the apex truncated. It is formed poſteriorly by the dorſal portion of the vertebral column which we have already deſcribed, anteriorly by a flat bone called the *ſternum*, and on the ſides by twenty-four oſſeous arches called the *ribs*.

The *ſternum* is a long flat bone: its ſuperior extremity is articulated with the clavicles; the other is free, and ſupports a cartilage which ſometimes oſſifies, and which is named the *xyphoid*, or *enſiform* cartilage, and in the new nomenclature *appendix ſternalis*. The two long ſides of this bone receive the cartilages of the ſeven firſt ribs into ſmall depreſſions. The ſternum is often found of two parts, but theſe generally become anchyloſed with age. This bone is covered on each ſide, both within and without the thorax, by a very ſolid ligamentous tunic. Its abdominal appendix is alſo ſupported by a ſtrong ligament, which paſſes from its external ſurface obliquely to the cartilage of the laſt *ſterno-vertebral* or true rib. This ligament prevents the appendix from being diſplaced by violent actions of the cheſt.

The *ribs* are twelve in number on each ſide. They are long bones, ſomewhat compreſſed, curvated throughout the whole of their length, and have their concave ſides turned towards the inner part of the thorax. One of their extremities terminates in two little articular ſurfaces, divided by a projecting line. It is received by the lateral part of the bodies of two vertebræ. This vertebral extremity of the rib becomes ſomewhat narrowed, and then preſents a new articular ſurface at the poſterior part, which correſponds with the tranſverſe proceſs of the more inferior of the two vertebræ to which the rib is articulated. The rib continues to bend backward in the ſame manner, but ſuddenly deviates from this direction and comes forward. The point where this change takes place is different in every rib. In the ſuperior ribs it is very near the vertebræ, but in the inferior removed to a conſiderable diſtance from them. This point, which receives the tendons of ſome muſcles, is called the *angle of the rib*. The ſternal extremity has a little depreſſion, into which the intermediate cartilage that unites it to the *ſternum* is received. Only ſeven ribs extend directly to the ſternum; they are called *true ribs*, or, with more propriety, *ſterno-vertebral*: the other five ribs have cartilaginous elongations, by which they are united with one another: they are called *falſe ribs*, or ſimply *vertebral*.

The human ribs are bent in ſuch a manner, with reſpect to their axis, that when laid upon an horizontal plane, one end is always elevated.

The ribs have only a limited motion upward and downward. Their articulations are ſtrengthened by a great number of ligaments. The articular ſurfaces of the vertebral extremity have capſules, which retain them upon the bodies and tranſverſe proceſſes of the vertebræ. The ſpace included between theſe ſurfaces is alſo made ſecure by two ligaments, one inſerted into the tranſverſe proceſs of the ſuperior vertebra on the inſide, and the other into the inferior articular proceſs of the ſame vertebra, but on the external ſide. The ſternal extremity is alſo ſurrounded by a little capſule, which joins it to the prolonged cartilage. There is, beſides, in all the ſpaces between the ribs, a ligamentous expanſion, which unites the inferior edge of one rib to the ſuperior edge of the next.

The laſt vertebral rib has a ſmall ligament peculiar to itſelf, which attaches it inferiorly to the tranſverſe proceſſes of the firſt and ſecond vertebræ of the loins.

B. *In other Mammiferous Animals.*

The figure of the thorax in the inferior mammalia is liable to variation. In thoſe that have no clavicles, it is commonly compreſſed on the ſides, and the ſternum forms an anterior projection more or leſs conſpicuous: the breaſt is moſt elongated in the ſarcophaga.

The number and form of the ribs vary alſo conſiderably in different families. In the Quadrumana they are always from twelve to fifteen. In the vermiform ſarcophaga they ſometimes amount to ſeventeen, which are generally very cloſe. They differ but little with reſpect to number in the other families. In the herbivorous quadrupeds they are broad and thick. The *horſe* has eighteen, the *rhinoceros* nineteen, and the *elephant* twenty. The *two-toed ſloth*, in which there are twenty-three on each ſide, has of all animals the moſt. The *armadillo* has the two firſt ribs exceedingly large in proportion to the reſt. The *two-toed ant-eater* has the ribs ſo broad, that they overlap each other like the tiles of a houſe. This conſtruction renders the ſides of the thorax very ſtrong in that animal.

The ſternum of the *orang* and *pongo* is broad. In every other ſpecies of ape it is narrow, and formed of ſeven or eight pieces.

All the *bats* have the ſternum narrow, but it exhibits on its front part a ridge; and the anterior extremity, which is enlarged on the ſides like a T, paſſes over the ribs to receive the clavicles.

In the *mole*, the clavicular extremity of the *ſternum* is prolonged before the ribs: it is compreſſed laterally, and receives the two ſhort clavicles under the neck.

The *hog* has the ſternum much enlarged behind, and narrow before.

In the *rhinoceros*, the *horſe*, and the *elephant*, the ſternum is prolonged anteriorly, and flattened on the ſides.

The Cetacea have the ſternum broad, but of no great thickneſs, eſpecially at the anterior part.

TABLE of the Number of Ribs in Mammiferous Animals.

SPECIES.	Total.	True.	Falſe.
Man	12	7	5
Sai, or Weeping Monkey	13	9	4
Orang	12	7	5
Pongo	12	7	5
Ternate Bat	13	7	6
Common Bat	12	7	5
Mole	13	8	5
Hedge-hog	15	7	8
Bear	14	9	5

SPECIES.	Total.	True.	Falſe.
Seal	15	10	5
Glutton	14	9	5
Racoon	14	9	5
Otter	14	9	5
Lion	13	9	4
Cat	13	9	4
Wolf	13	9	4
Opoſſum	13	7	6
Hare	12	7	5
Guinea Pig	13	6	7
Three-toed Sloth	16	8	8
Long tailed Manis	13	6	7
Elephant	20	7	13
Hog	14	7	7
Rhinoceros	19	7	12
Dromedary	12	7	5
Girafe	14	8	6
Ox	13	8	5
Stag	13	8	5
Horse	18	8	10
Dolphin	13	6	7
Porpoiſe	13	6	7

C. *In Birds.*

The thorax of birds is in general very large; it is, however, formed by the ribs and the ſternum only; but this laſt bone differs both as to figure and dimenſions from the ſternum of the mammalia.

The ribs exhibit many peculiarities. They may be diſtinguiſhed into *ſterno-vertebral*, and *vertebral*, properly ſo called; but they are not ſituated as in mammiferous animals. The vertebral ribs are moſt commonly the anterior, but ſometimes ribs of this kind are alſo ſituated poſteriorly. The vertebral extremity is bifurcated; one of the branches reſts upon the body of the vertebra, and the other upon its tranſverſe proceſſes. The ſternal extremity receives an oſſeous appendage, which ſupplies the place of the ſterno-coſtal cartilage: with this bone it forms an obtuſe angle, the open part of which is turned forward.

The middle part of the rib preſents likewiſe another peculiar characteriſtic. On its poſterior edge is a flat proceſs, directed obliquely towards the back, above the ſucceeding rib, ſo that all the ribs have points of ſupport on each other.

The ſternum of birds is very broad, and almoſt ſquare, but not thick. It covers not only the thorax, but the greater part of the abdomen. Its internal or poſterior ſurface is concave. The exterior convex, and in all thoſe that fly, it bears upon its middle line a projecting creſt reſembling the keel of a ſhip. The clavicular extremity of this bone is truncated to receive on each ſide the two great clavicles. The abdominal extremity is thinner, and frequently perforated with holes to increaſe its levity. It is likewiſe ſometimes truncated, and only forms two angles more or leſs extended; at other times it forms three angles on each side very diſtinct, as in *jacana* and *king's-fiſher*.

The magnitude of the ſternum, and the ſhape of its keel, ſeem intended to give very extenſive origins to the muſcle that depreſs the wing.

They are various as the habits of the bird with reſpect to its mode of flight, whether it be high or low, ſwift or ſlow, or continued during a longer or ſhorter period.

The ſternum of the *oſtrich* and *caſſowary*, which do not fly, has no creſt; but it is large, and rounded like a buckler.

It is the narrowneſs of the ſternum which gives to *rails* and *water hens* that compreſſed ſhape which characterizes their habits.

It is likewiſe very narrow, and entirely oſſeous, in the common *crane* and *demoiſelles de Numidie*, and the males have the prominence of the creſt hollowed to lodge the convolutions of the trachea.

In the gallinaceous tribe, the creſt of the ſternum begins very low, and its elevation is marked by two projecting lines, which riſe gradually, in a concave curve, to form that creſt. Theſe double lines are likewiſe found, though much ſmaller, in the *owl* and *ſpoon-bill*.

The *herons*, the *ſwan*, the *ſparrows*, and the *raven*, have only one elevated line at the origin of the creſt. In the *heron* it has a very prominent and convex edge. In the *ſwan* and *duck* it forms a ſtraight line.

D. *In Reptiles.*

The thorax of reptiles is very various in its ſtructure. *Frogs* have a ſternum, but no ribs;

ſerpents have ribs, but no ſternum; *tortoiſes* have the ribs oſſified to the back ſhell, and the ſternum included in the breaſt-plate; the *crocodile* and *lizard* have perfect ribs, but their ſternum is almoſt entirely cartilaginous.

In the *crocodile*, the firſt portion of the ſternum is oſſified and elongated. It receives the two clavicles. The remaining part is entirely cartilaginous. It is united with the os pubis, and ſends off eight cylindrical cartilages to the parietes of the abdomen. The ribs are twelve in number; the two firſt and two laſt of which are not attached to the ſternum. The intermediate ribs have upon their poſterior edges cartilages partly oſſified, which ſupply the place of the angles of the ribs in birds. All the poſterior ribs, beginning at the fifth, are only articulated to the tranſverſe proceſſes of the vertebræ, which are of great length. The five firſt articulate with the vertebræ at two points, one on its body, and the other on the tranſverſe proceſs.

The *iguana* and the *tupinambis* have only the upper part of the ſternum oſſified. It is broad, and receives ſix ribs and the clavicles. The other ribs are free.

The *cameleon* poſſeſſes likewiſe the upper portion of the ſternum; but almoſt all the ribs have cartilages which extend to the middle line, and are there united to the oppoſite ones.

Frogs, though they have no ribs, have nevertheleſs a very conſpicuous ſternum. It forms on the anterior part a cartilaginous appendix, furniſhed by a diſk ſituated below the larynx. It next receives the clavicles, and then expanding, it terminates at laſt in another diſk ſituated under the abdomen, and which affords an origin for muſcles.

The *ſalamander* has ribs ſo ſhort that they ſeem to be the tranſverſe proceſſes of the vertebræ; they have only one point of articulation, upon which they have but little motion. Theſe rudiments of ribs are twelve in number on each ſide. This reptile has, properly ſpeaking, no ſternum, but its place is partly ſupplied by the bones of the ſhoulder, as we ſhall preſently ſee.

The back ſhell of the *tortoiſe* is formed by the expanſion of eight ribs or oſſeous ſtaves, which ariſe from the joints of the vertebræ, and terminate in a border that ſurrounds the whole ſhell: theſe bones are united together by real ſutures, ſituated tranſverſely.

Above and all along the middle part we obſerve a row of little oſſeous plates, almoſt ſquare, intimately connected by ſynarthroſis, and equal in number to the vertebræ, of which they conſtitute a part.

The oſſeous margin is made up of a great number of pieces ſoldered together, which, by their union, form an edge or border with three ſurfaces, viz. the ſuperior, which belongs to the back ſhell; the inferior, which is joined to the breaſt-plate by a very thick leather-like ſkin;

and the internal, which preſents a groove for the reception of the extremities of the ribs. But this margin aſſumes a different appearance at its anterior part; it is there a ſquare piece of bone, convex above and concave below, which ſuſtains a ſpine for the attachment of muſcles. Its anterior edge has more the form of a creſcent; there are alſo ſome little peculiar pieces above the tail.

The breaſt-plate of the *tortoiſe*, when deprived of the thick ſkin that covers it, exhibits, in ſome ſpecies, only one ſolid plate, formed of ſeveral pieces, united by ſynarthroſis: in others, this plate is perforated quite through, and formed of ſeveral bones, ſome of which are ſituated in the middle line between the anterior and poſterior part, while others are placed laterally, and faſtened together by the help of the former, which ſupport them.

E. *In Fiſhes.*

Fiſhes have, properly ſpeaking, no thorax; all the cavity of the trunk being occupied by the abdominal viſcera. This cavity varies very much in extent and figure; it is compreſſed at the ſides, and flattened or ſomewhat rounded horizontally. In different ſpecies, its length conſtitutes a greater or leſs portion of the whole length of the body. In general, fiſhes of the order *abdominales* have this cavity proportionably longer; but this rule is not conſtant. The cavity is bounded poſteriorly by the inferior proceſs of the firſt caudal vertebræ, which is often very large, and has almoſt always a peculiar ſhape. In the *pleuronectes*, for inſtance, it is large, round in the fore-part, and terminated below by a ſort of ſpine.

The abdominal cavity is encloſed laterally by the ribs when they exiſt: For example, the *rays*, the *ſharks*, the *pipe-fiſh*, the *ſun-fiſh*, the *porcupine-fiſh*, the *lump-fiſh*, the *fiſtularia*, &c. have no ribs.—The *ſturgeons*, the *baliſtes*, the *eels*, the *uranoſcopes*, the *pleuronectes*, the *ſea-wolves*, and the *dorées* have them very ſhort. The *gurnards*, the *loricariæ*, the *uranoſcopes*, and the *bull-heads*, &c. have their ribs ſomewhat horizontal. They ſurround the cavity almoſt to its top in the *perch*, *carps*, *pikes*, *chetodons*, &c. Finally, they unite in a ſort of ſternum in the *zeus vomer*; the *herrings* or *clupeæ*, the *ſalmorhomboides*, &c. The *ſyngnathus hippocampus*, or little ſea-horſe, has a ſort of falſe ribs produced by the oſſeous tubercles of his ſkin, which ſurrounds his body like belts.

its

Only a very few fiſh can be properly ſaid to have a ſternum: beſides thoſe juſt enumerated, there are ſome in which the ſternum does not furniſh attachment to the ribs: ſuch is the *doree (zeus faber)*; if indeed that can be called a ſternum, which is only a ſeries of ſmall bones, without

out articulation, running along the whole inferior edge of the abdomen.

The number and ſize of the ribs are likewiſe extremely various. The *ſiluri*, the *carps*, and the *chetodons* have them proportionably larger. In the herring, on the contrary, they are as ſmall as hairs: many fiſhes have them forked; others have them double, or, in other words, two ribs proceed from each ſide of every vertebra.

Article IV.

Of the Muſcles of the Ribs and Sternum.

A. *In Man.*

The ribs, by their motion, do little more than ſerve the purpoſes of inſpiration and expiration. The muſcles acting upon theſe bones either elevate or depreſs them.

The following are thoſe which elevate the ribs:

THE SCALENUS, *or* TRACHELO COSTALIS,

Ariſes from the tranſverſe proceſſes of the five lower vertebræ of the neck, and is inſerted into the poſterior part of the three firſt ribs, by four digitations.

THE

THE INTERCOSTALES INTERNI *and* EXTERNI,

Theſe muſcles form two layers, and occupy all the intervals between the ribs. Their fibres are oblique, and in oppoſite directions; thoſe of the external layer tend from a ſuperior rib towards the cartilage of the next rib; thoſe of the internal are directed from the cartilage of the inferior rib towards the angle of the ſuperior, or backward.

THE LEVATORES COSTARUM, *or* TRANSVERSO-COSTALES,

Extend from the tranſverſe proceſs of the laſt cervical, and from thoſe of the eleven firſt dorſal vertebræ to the angle of the ribs.

THE SERRATUS POSTICUS SUPERIOR, *or* DORSO-COSTALIS,

Ariſes from the ſpinous proceſſes of the two laſt cervical, and the two firſt dorſal vertebræ, and is inſerted into three or four of the uppermoſt true ribs, the firſt rib excepted.

The muſcles that lower or depreſs the ribs are—

THE SERRATUS POSTICUS INFERIOR, *or* LUMBO-COSTALIS.

This muſcle ariſes from the ſpinous proceſſes of the three laſt vertebræ of the back, and the two firſt of the loins, and is inſerted by digitations into the four laſt falſe ribs. It pulls them outward and downward.

The ſternum has only one muſcle, and this manifeſtly acts in depreſſing the ribs: it is called

TRIANGULARIS STERNI, *or* STERNO-COSTALIS.

It ariſes from the inferior and middle part of the ſternum, and aſcends to the cartilages of the five loweſt true ribs.

Other muſcles are likewiſe attached to the ribs; but their action upon thoſe bones, which ſeem only intended to give them firm inſertions, is leſs conſpicuous. Theſe are the *diaphragm* and the muſcles of the abdomen, which ſerve for reſpiration, and for the formation of the moveable parietes of the abdomen.

THE DIAPHRAGM.

Is a fleſhy and tendinous partition, which divides the cavity of the thorax from that of the lower belly. It is ſituated obliquely between the appendix ſternalis, and the bodies of the lumbar vertebræ. This muſcle is attached to the ſternal appendix, the two loweſt true ribs, and the edge of the cartilages of all the falſe ribs: poſteriorly it is inſerted into the lumbar vertebræ, by two columns of fleſh, called *crura*. This muſcle is tendinous in the middle, and fleſhy about the edges. It is covered above by the pleura, and below by the peritoneum: its uſes will be more particularly explained when we treat of Reſpiration. It has three perforations in its poſterior part; that on the right gives paſſage to the vena cava; the œſophagus paſſes through that on the left; and the aorta, vena azygos, and thoracic duct paſs through the poſterior foramen.

The parietes of the abdomen are formed by five pairs of muſcles: theſe are —

THE OBLIQUUS EXTERNUS, OBLIQUUS MAGNUS, *or* COSTO-ABDOMINALIS.

This muſcle ariſes from the eight laſt ribs by as many digitations, and is inſerted into the creſt of the os ilium and os pubis. Its fibres deſcend from without inwards.

THE OBLIQUUS INTERNUS, OBLIQUUS PARVUS, *or* ILIO ABDOMINALIS,

Ariſes from the creſt of the os ilium and os pubis. It is inſerted into the edges of all the falſe ribs, and even the laſt true one, and the ſternal appendix. Its fibres deſcend from within outwardly.

THE RECTUS ABDOMINIS, *or* PUBO-STERNALIS,

Is attached to the ſuperior part of the pubis. It is inſerted into the three laſt ſterno-vertebral ribs, into the firſt vertebral rib, and the appendix ſternalis, by four digitations. This muſcle in its paſſage is covered with an aponeurotic ſheath produced from the oblique muſcles. It is even inſerted into ſome points of that ſheath. This occaſions the formation of ſeveral tendinous tranſverſe lines, which are generally four in number.

THE PYRAMIDALIS, *or* PUBO-UMBILICALIS,

Ariſes likewiſe from the ſuperior part of the pubis, and, diminiſhing much in breadth as it aſcends, is inſerted into the linea alba, near the umbilical ring.

THE TRANSVERSALIS ABDOMINIS, *or* LUMBO-ABDOMINALIS,

Is affixed at one part by a broad, thin, and almoſt aponeurotic tendon, to the tranſverſe and ſpinous proceſſes of the four ſuperior lumbar vertebræ, and extends its fibres almoſt tranſverſely to the linea alba.

The recti and pyramidales bend the trunk forward. The obliqui have the power of inclining it laterally; finally, the tranſverſe muſcles act upon the parietes of the abdomen like a girth, and compreſs it on every ſide.

B. *In other Mammiferous Animals.*

The muſcles of the ribs exhibit no remarkable difference in the other orders of mammalia.

Thoſe of the lower belly differ ſomewhat from the ſame muſcles in man as to their proportional length. This difference, however, is more perceptible in the *recti* and *pyramidales*; for in the ſarcophaga the recti often extend to the anterior extremity of the ſternum, and then the pyramidales are generally wanting.

The *diaphragm*, in *bats*, has two very ſtrong crura, which form a kind of fleſhy ſeptum, placed longitudinally on the ſpine within the abdomen.

In the article on Generation, we ſhall deſcribe the muſcles peculiar to the abdominal bag of the *didelphis* or *opoſſum*.

C. *In Birds.*

The *ſcalenus* differs in no reſpect from the *levatores coſtarum*, which extend from the tranſverſe proceſſes of each vertebra, to the anterior edge of each rib. The ſuperior layers are the thickeſt, and they become very thin at the laſt ribs.

The *internal* and *external intercoſtals* have alſo an oppoſite direction in their fibres, but they occupy only the intervals between the bend of the articulations and the angular proceſſes, except in the laſt ribs, which have no proceſſes, and where thoſe muſcles are found both on the anterior and poſterior parts.

The *triangularis ſterni* comes from the ſuperior and lateral part of the ſternum, and proceeds to the edge of the ſecond articulation of the firſt ſterno-vertebral rib. It there ſends off other fibres, which are inſerted in the ſecond and following ribs. Theſe fibres become gradually thinner, and their direction is nearly parallel to the axis of the body of the bird.

There is no *diaphragm* in birds.

Their abdomen is covered with three layers of muſcles, which are all tranſverſe, though their fibres have different obliquities.

That which is analogous to the *obliquus externus* has its fibres tranſverſe. It is attached to the creſt of the illium, covers the elongations of the ſternum, and is inſerted into the ſecond or third rib. Its poſterior aponeuroſis is very thin; that which unites it to its fellow is very ſtrong.

The *obliquus internus* is entirely fleſhy, and is not quite ſo broad as the preceding. It ariſes from the poſterior edge of the laſt rib, and is inſerted into the anterior edge of the *os ilium*.

The muſcle analogous to the *tranſverſalis* forms the third layer. Its tranſverſe fibres are ſomewhat divided, and as it were faſciculated; it has the ſame inſertions as the preceding.

Both the *muſculi recti* and *pyramidales* are wanting.

D. *In Reptiles.*

In the *frog*, which wants ribs, and the *tortoiſe*, where they are immoveable, the muſcles which uſually have their inſertions in them, are in thoſe animals extended to other parts.

Thus, in the *tortoiſe*, whoſe *breaſt-plate* occupies the place of the abdominal muſcles, they are inſerted into the *pelvis*, which they move.

With reſpect to thoſe animals, one very remarkable obſervation may, in general, be made: —It appears that the very ſingular ſhape of the muſcles and bones depend upon each other. Indeed, as the muſcles are not placed upon the bones, they have not, if we may be allowed the expreſſion, faſhioned them; and the want of motion in the bones, which has given an unnatural figure to the trunk, has alſo given to the muſcles other forms and other uſes.

The abdominal muſcles of the *frog* preſent nothing peculiar, except that the ſkin does not adhere to their ſurfaces, and that, inſtead of being inſerted into the rib, they are faſtened to the ſternum by a ſtrong aponeuroſis.

The ſame obſervations may be made with reſpect to the *ſalamanders*.

E. *In Fiſhes.*

The ſpaces between the ribs are filled up by ſhort oblique fibrous muſcles, analogous to the intercoſtals; but the great lateral muſcles, which are inſerted alſo into the ribs, move them all at once, ſomewhat in the ſame manner as they act upon the vertebræ of the tail.

ARTICLE V.

Of the Motions of the Head upon the Spine.

THE head may be conſidered under two points of view. 1ſt. As an oſſeous cavity, which contains and preſerves the brain and the principal organs of ſenſe: this is the view we ſhall have to take of it in the ſecond part of the courſe.

2d. As a maſs more or leſs weighty, articulated with the neck, and capable of being moved upon it in different directions. In this latter reſpect it now claims our attention.

A. *In Man.*

The human head is compoſed of two parts: firſt, an oval caſe, called the *cranium*, the top and ſides of which have almoſt the ſame convexity, but the inferior ſurface is more plain, and tends obliquely forward, the poſition of the body being ſuppoſed erect. Beneath the anterior portion of this diviſion of the cranium, is placed the ſecond part of the head, which we call the *face*. The form of this part is nearly priſmatic; the baſe, where the palate is ſituated, is parabolical; the face is directly croſſed from the anterior to the poſterior part by the *canal of the noſtrils*; and in front, towards the upper part, it is enlarged to make room for the *orbits*. A kind of branch, which ſprings from each ſide, and which, running backward, rejoins the cranium, is called the *zygomatic proceſs*. Beneath the place where this joins the cranium, is the articulation of the *lower jaw*, which, with the cylindrical part above mentioned, completes the face. One of the characteriſtics peculiar to man is, that the jaws project very little before the ſuperior and anterior part of the cranium, which we call the *forehead*.

We ſhall not here enter into a minute detail of the holes, ſutures, eminences and depreſſions of all the different parts of the head, but return to them in a ſubſequent article.

The part of the inferior ſurface of the cranium, ſituated farther back than the face, is called the *occiput*, or, more particularly, the baſis of the cranium. The occiput has an irregular convexity, of a different curvature from that of the cranium, and is ſeparated from it behind by a projecting line, repreſenting two arches of circles, which are called the *occipital arches*.

The lateral extremities of this line exhibit each a large tuberoſity, called the *maſtoid proceſs*, which is ſituated behind the hole of the ear, but ſomewhat lower. At the internal part of its baſe is a depreſſion called the *maſtoid groove*. Exactly between the two maſtoid proceſſes is the *foramen magnum*, which affords a paſſage to the ſpinal marrow, in its progreſs from the cranium into the common canal of the vertebræ.

The oſſeous part, ſituated before this foramen, and at the poſterior baſe of the ſemi-cylinder, which forms the face, is called the *cuneiform* or *baſilary proceſs*.

A ſtraight projecting line extends from the middle of the occipital arch to the edge of the foramen. It is called the *ſpine of the occiput*, and its poſterior extremity forms an eminence called the *occipital tuberoſity*.

The head is articulated to the top of the firſt vertebra, in ſuch a manner that the canal of the latter correſponds with the foramen magnum.

This articulation is formed by two prominent ſurfaces, ſituated on the anterior edges of the foramen magnum, and turned ſomewhat forward and outward.

Theſe eminences are called the *occipital condyles*; they are received by two correſpondent cavities of the *atlas*, and with it form a ginglimus, that permits no perceptible motion of the head, except forward and backward.

The *atlas* is articulated in the ſame manner by two lateral, and ſomewhat anterior ſurfaces, to the *axis* or *dentata*. Theſe ſurfaces being, however, more plain, permit a rotatory motion to the atlas and head, upon the *axis*, whence that vertebra derives its name.

The anterior part of this ſecond vertebra produces a proceſs which riſes behind the anterior part of the atlas, and joins it by an articular ſurface. It has been compared to a tooth, and called *odontoid*.

The reſt of the rotatory motion of the head is performed by the twiſting of the cervical part of the ſpine.

Finally, the motion which inclines the head to the right and left, though partly performed by the articulation of the occiput to the atlas, is principally effected by the five lower cervical vertebræ, the articular ſurfaces of which, being turned directly backward, admit of much freedom in the lateral direction.

Several ligaments ſtrengthen this articulation, and facilitate its movements. Some unite the arches of the atlas to the occiput, and form two ſtrong membranes; others ſurround the condyles at their articulation with the atlas, and form a capſular ligament. Beſides, a ligament proceeds from the top of the odontoid proceſs, and is inſerted into the anterior border of the foramen magnum, determining the axis of motion. There are alſo lateral ligaments; and finally, leſt this proceſs ſhould injure the ſpinal marrow contained in the vertebral canal, there is a ligament ſituated tranſverſely in the interior part of the ring of the atlas, which retains it in its place.

The poſition of the two condyles, upon which the head reſts, is ſuch that they nearly biſect a line drawn from the moſt projecting part of the occiput to the dentes inciſores. The conſequence of this diſpoſition is, that, in the erect poſition, the head is in equilibrium upon the ſpine.

The plane of the foramen magnum is nearly perpendicular to that of the eyes, and parallel to that of the palate; on which account the eyes and mouth are both directed forward when we ſtand upright.

Theſe two diſpoſitions take place completely in the human ſpecies alone. Even the Negroes have the anterior part of the line above mentioned longer than the poſterior, becauſe their jaws are ſomewhat elongated.

B. *In other Mammiferous Animals.*

In the *orang-outang*, the jaws are not only more elongated, but the occipital hole ſeems to retire backward, and aſcend along the poſterior ſurface of the cranium, ſo that its plane forms an angle of 60° only, with that of the orbits.

This elongation increaſes, in quadrupeds, in proportion as they recede from man. The jaws, at laſt, not only conſtitute three-fourths of the head, but the cuneiform proceſs being prolonged, the foramen and the ſurface of the occiput are gradually removed backward and upward: at laſt their poſition is no longer below, but behind the head; and the plane of the foramen, forming angles, more and more acute, with the plane of the orbits, becomes parallel to it, and at length no longer interſects it below, but above the head.

This accounts for the difference of the direction of the head in quadrupeds, which is ſo great, that, were the ſpine vertical, the head could not be preſerved in equilibrio, unleſs the eyes were turned backward, and the mouth upward.

When ſtanding upon the four feet, the head of a quadruped is not retained upon the ſpine by its own proper weight, but by the muſcles and ligaments only; particularly that ligament called the *cervical*, which riſes from the ſpinous proceſſes of the vertebræ of the neck and back, and is inſerted into the ſpine of the occiput.

As man has no need of this ligament in his ordinary poſition, it is in him ſo weak that many anatomiſts have denied its exiſtence.

Quadrupeds, on the contrary, have it ſtronger in proportion as the head is larger or longer. In the *horſe*, its inſertion into the vertebra of the back is as broad as two hands, and it is faſtened by ſtraps to three or four of the vertebræ of the neck. The Carnivora have it ſomewhat leſs; but in the *elephant* it is largeſt of all, and is there inſerted into a particular depreſſion of the occiput. The *mole* has this ligament oſſified in a great meaſure, as it is employed not only in raiſing the head, but alſo conſiderable maſſes of earth.

In the inferior mammalia, the occipital ſurface of the cranium making a much more acute angle

with

with the vertex than it does in man, the occipital arches become more diſtinct and pointed; and they aſſume different figures in different ſpecies. The maſtoid proceſſes always preſerving the ſame inclination to the plane of the palate, gradually diminiſh the angle which they make with the occipital ſurface, till they finally arrive at the ſame plane.

In *monkies* in general the maſtoid proceſſes are nearly obliterated. In all theſe ſpecies which have the jaw elongated, and ſtrong canine teeth, the occipital arches form a projecting ridge. Such in particular is the caſe with the *Chineſe-ape*, *Barbary-ape*, *cynocephalus*, *hare-lipped-ape*, *baboon*, *mandril* and *pongo*.

The *bat* has the baſis of the cranium, as it were, curved, and the great foramen ſituated on the poſterior part. The tranſverſe proceſſes of the firſt vertebra are flat on the ſides. The proceſſes encloſing the organs of hearing, which are very large, and as it were inflated, exhibit a large projection at the baſe of the ſkull.

The baſe of the cranium and the occiput are deprived of proceſſes in the *mole*.

The *bear*, and in general all the large Sarcophaga, have, at the poſterior ſurface of the head, projecting ridges, in a direction almoſt perpendicular to the foramen magnum; the tranſverſe proceſſes of the atlas are alſo very large.

The *lion*, the *tiger*, the *wolf*, and the *fox*, have the occipital protuberance very prominent; their heads are almoſt triangular behind.

In the Rodentia the face is very long: the cranium is alſo elongated, and rounded above, and flat below; the articulation behind, and the tranſverſe proceſſes of the atlas, are enlarged.

The cranium of the *ant-eater* is round, and has no projecting proceſſes, though the face is conical, and very long.

The *elephant* has the head truncated almoſt vertically behind. The occiput is, as it were, ſquare, and the condyles are at the poſterior extremity. The place of the occipital protuberance is occupied by a conſiderable depreſſion, in which there is a longitudinal ridge for the inſertion of the cervical ligament.

In the *hog*, the occipital tuberoſity is large, with depreſſions, and almoſt perpendicular to the condyles.

The *rhinoceros* has the occiput more oblique, and the atlas as broad as the head.

The Solipeda and Ruminantia have the tranſverſe proceſſes of the atlas flatted, and turned forward, and the maſtoid proceſſes elongated. The motion of the head forwards and to the ſide is therefore much circumſcribed by this conformation.

Finally, the Cetacea have a broad atlas anchyloſed with the axis. Two articular depreſſions correſpond with the large condyles of the occiput. The articulation is formed at its poſterior extremity.

C. *In Birds.*

The head of birds is ſo conſtructed as to perform very evident motions upon the vertebral column. It is always articulated behind, by a ſingle condyle, or hemiſpherical tubercle, ſituated at the lower part of the foramen magnum. This tubercle is received into a correſpondent depreſſion in the body of the firſt vertebra.

Hence there is not only a more extenſive vertical motion, but likewiſe a horizontal rotatory motion. Indeed we often ſee birds, when they wiſh to ſleep, turn their heads ſo as to place their bill between their wings; but no quadruped can put his ſnout in that poſition.

The maſtoid proceſſes is prolonged in a prominent ridge, running downward and forward towards the middle line, where it joins that from the oppoſite ſide.

The occiput is round in thoſe that have ſhort bills, but it is flattiſh, and exhibits a kind of creſt in thoſe that have the beak long.

In the *cormorant*, the occipital protuberance ſupports a long triangular bone, which ſeems to be produced by the oſſification of the cervical ligament.

The firſt vertebra in birds is a ſimple oſſeous ring, a little more thick on the anterior part. It articulates above with the occipital condyle, and below by a flat ſurface with the ſecond vertebra.

The ſecond vertebra in birds bears a tooth-like proceſs on the upper ſide, but it is very ſhort, and proportioned to the height of the ring of the atlas.

D. *In Reptiles.*

The articulation of the head of reptiles is conſiderably behind; but the motions vary in different ſpecies.

In the *crocodile* there is only one condyle, ſituated at the under ſide of the foramen magnum: the atlas is formed of two portions; the poſterior is ſhaped like the ſegment of a ring: the anterior, which is thicker, receives the condyle, and is articulated to the ſecond vertebra: there are two lateral proceſſes, long, flat, and turned backward, which ſupply the place of tranſverſe proceſſes.

The odontoid proceſs of the ſecond vertebra is ſhort and thick; it is articulated within a cavity in the body of the atlas. This ſecond vertebra has tranſverſe proceſſes ſimilar to thoſe of the firſt.

All other *lizards* have nearly the ſame conformation; but the condyle ſeems divided in two by a longitudinal ſuperficial furrow.

The *tortoiſes* have likewiſe only one condyle. In the land ſort it is prolonged, and divided into two, as it is in the lizards. In the marine ſpecies it preſents three articular faces, like a trefoil leaf. As this condyle penetrates deep into the correſpondent cavity of the atlas, the lateral motion of the head is much confined. The other motions of the head of the tortoiſe are thoſe of projection and retraction; they depend upon the flexion and extenſion of the cervical vertebræ, and have been deſcribed already.

The *frog*, the *toad*, and the *ſalamander*, have the head articulated by two condyles upon the firſt vertebra, which is almoſt immoveable.

Serpents have three ſurfaces, in the manner of a trefoil, cloſe together, upon one condyle, beneath the occipital foramen. The head is not more moveable on the atlas, than the reſt of the vertebræ are upon each other.

E. *In Fiſhes.*

The occiput of fiſhes appears like a vertical truncation of the cranium. The tubercle by which it is united to the vertebræ is ſingle, and placed below the occipital foramen. This union is effected by the intervention of cartilages with flat or concave ſurfaces, ſo that the motion is much confined on every ſide. The ſuperior part of the occiput in ſome ſpecies preſents flat and very prominent lateral proceſſes, and, in particular, a longitudinal ſpine, which terminates above the foramen magnum.

The baſis of the cranium, in moſt kinds, is only formed by a longitudinal ridge, more or leſs round.

In ſome ſpecies, ſuch as the *whiting*, the *perch*, the *ſalmon*, &c. the occipital protuberance is very long, and ſharp-edged.

The *ſharks* and *rays* have their heads articulated with the vertebral column, by two condyles; but this articulation is almoſt immoveable, and is made ſecure by ligamentous fibres.

ARTICLE VI.

Of the Muſcles of the Head.

A. *In Man.*

THE muſcles which move the human head ariſe from the firſt, the ſecond, or from ſeveral other cervical vertebræ.

Thoſe that ariſe from the atlas are,

1. THE RECTUS CAPITIS POSTICUS MINOR, *or* ATLOIDO-OCCIPITALIS,

Riſes from the ſpinous proceſs of the firſt vertebra, and is inſerted into the middle of the poſterior edge of the foramen magnum. It draws the occiput directly backward, and moves the head upon the atlas.

2. THE RECTUS CAPITIS ANTICUS MINOR, *or* TRACHELO-SUB-OCCIPITALIS.

This little muſcle ariſes from the anterior annular part of the atlas, and is inſerted into the cuneiform proceſs. The motion it produces is directly the oppoſite of the preceding: it bends the head forward and downward.

3. THE RECTUS CAPITIS LATERALIS, *or* MASTOIDO-ATLOIDEUS.

This muſcle ariſes from the tranſverſe proceſs of the atlas, and is inſerted into the maſtoid proceſs of the ſame ſide: it bends the head a little towards the ſhoulder.

4. THE OBLIQUUS CAPITIS SUPERIOR, *or* ATLOIDO-SUB-MASTOIDEUS.

This muſcle ariſes from the ſame proceſs as the preceding, and aſcends, internally, towards the poſterior edge of the foramen magnum, juſt by the maſtoid proceſs. Its action produces a ſlight rotation of the head upon the axis, at the ſame time that it brings it backward.

The muſcles which originate from the ſecond vertebra, are only two.

1. THE RECTUS CAPITIS POSTICUS MAJOR, *or* AXOIDO-OCCIPITALIS.

This muſcle ariſes from the ſpinous proceſſes of the axis, and is inſerted into the occiput over the *rectus capitis poſticus minor.* It covers that muſcle, and participates in its operation, cauſing however a more decided motion of the head backwards.

2. THE OBLIQUUS CAPITIS INFERIOR, *or* AXOIDO-ATLOIDEUS,

Ariſes from the ſame ſpinous proceſs, and proceeds outwardly towards the tranſverſe proceſs of the atlas, into which it is inſerted; this is, therefore, rather a muſcle of the ſpine than of the head. It turns the atlas upon the axis, thus producing the lateral motion of the firſt cervical vertebra.

There are five muſcles of the head, proceeding from the other cervical vertebræ.

1. THE COMPLEXUS MAGNUS, *or* TRACHELO-OCCIPITALIS,

Ariſes by digitations from the tranſverſe proceſſes of the four laſt cervical and three firſt dorſal vertebræ. It paſſes over the back of the neck, in its way to its inſertion in the occiput, above all the preceding. It is cloſely united, by its lower ſurface, with another called the biventer. This muſcle is evidently an extenſion, or a flexor of the head backward.

2. THE BIVENTER CERVICIS, *or* TRACHELO-DORSALIS.

This muſcle ariſes, in like manner, by digitations from the tranſverſe proceſſes of five vertebræ of the back, from the ſecond to the ſixth, and from the ſpinous proceſs of the firſt. It is inſerted into the occiput, above the preceding muſcle, to which it is ſimilar in uſe. Its middle being narrow and tendinous, it has, from that circumſtance, obtained the name of *biventer*.

3. THE COMPLEXUS MINOR, *or* TRACHELO-MASTOIDEUS,

Ariſes by digitations from the tranſverſe proceſſes of the ſix laſt cervical vertebræ, and three firſt dorſal, and aſcends along the neck to the maſtoid proceſs, into which it is inſerted. It receives, near its inſertion, a long ſlip of muſcle from the longiſſimus dorſi. It bends the head backward, turning it at the ſame time a little upon its axis, when it acts without the correſpondent muſcle of the oppoſite ſide; but when theſe muſcles act together, they keep the head upright. They are antagoniſts of the ſterno-cleido-maſtoideus.

Theſe three muſcles are covered by,

4. THE SPLENIUS CAPITIS, *or* CERVICO-MASTOIDEUS.

This muſcle ariſes from the ſpinous proceſſes of the five laſt cervical and two firſt dorſal vertebræ. It is inſerted into the occipital arch near the maſtoid proceſs. It has the ſame uſe as the complexus minor. Its external part, which riſes from the two next dorſal vertebræ, and is inſerted into the tranſverſe proceſſes of the two upper cervical vertebræ, is regarded as a muſcle of the ſpine, and has been named *ſplenius colli.*

5. THE RECTUS CAPITIS ANTICUS MAJOR, *or* TRACHELO-SUB-OCCIPITALIS,

Extends along the cervical vertebræ, on the fore part, from the ſecond to the ſixth, and is inſerted into the cuneiform proceſs of the occiput. It bends the head forward.

Certain muſcles upon the ſhoulder, which are inſerted into the head, ſuch as the *trapezius, ſterno-cleido-maſtoideus,* the muſcles of the *larynx, os hyoides,* and *jaw,* all act upon the head, and might be demonſtrated here.

B. *In other Mammiferous Animals.*

The ſmall muſcles of the head are found in quadrupeds as well as in man, and with the ſame attachments; the only difference is, that they increaſe in magnitude proportionally with the two firſt vertebræ. Except, therefore, in the *monkey* and *cetaceous animals,* the *obliquus capitis inferior,* and *rectus capitis poſticus major,* are of very conſiderable magnitude.

In general the *biventer cervicis* is not divided into two portions by an intermediate tendon. In the Carnivora there are, throughout its whole length, tranſverſe tendinous interſections. It lies upon the complexus magnus, from which it is, however, very diſtinct; ſo much ſo, indeed, that theſe animals appear to have three complexi: but in the *horſe* it is completely united to the complexus on the upper parts.

The *ſplenius* is inſerted into the cervical ligament, in thoſe animals which have this ligament conſiderably elevated above the vertebræ. It is always larger than in man, but is ſtrongeſt in the *mole*. No part of this muſcle is attached to the tranſverſe proceſſes of the cervical vertebræ in the Carnivora. Such of its fibres as go to the maſtoid proceſs, are inſerted there by a tendon common to them and the complexus minor. In the *horſe*, the part of the ſplenius which belongs to the head is entirely inſerted into the maſtoid proceſs by a thin tendon common to it and the complexus minor, which receives no ſlips, except from the third cervical and the two firſt dorſal vertebræ. The ſplenius furniſhes beſides three ſlips to the tranſverſe proceſſes of the three cervical vertebræ next to the atlas. The tendon of the firſt is common to it and the *tranſverſalis colli.*

E. *In Birds.*

Birds have no *ſplenius*.—The *Biventer Cervicis* is completely ſeparated from the complexus. It extends from the middle of the back to the occipital arch. Its two bellies are ſimple and without proceſſes. Its middle tendon is very ſlender.

It ſeems to be wanting in thoſe birds which have very long necks, as the *heron*.

The *complexus magnus* is only inſerted into the articular proceſſes and lateral ſurfaces of a few of the cervical vertebræ; for inſtance, the third or fourth, or perhaps the ſecond or third.

The *complexus minor* riſes from the anterior ſpines of the third, fourth and fifth vertebræ, or ſometimes from the ſecond and third. It is inſerted into the occiput more outwardly than the preceding. Theſe three pairs of muſcles occupy the whole arch.

The *recti poſtici* are three in number in birds. The *minor* and *major* are analogous to thoſe of the human ſpecies; and the *rectus poſticus maximus*, which in them proceeds likewiſe from the ſpinous proceſs of the axis, covers the other two.

The *obliquus inferior, ſeu magnus*, is to be found, but not the *ſuperior*.

The *rectus lateralis* alſo exiſts in birds. Finally, the two *recti antici* are likewiſe preſent; but the *rectus major* ariſes only from the three or four firſt vertebræ.

D. *In Reptiles.*

The muſcles of the head of the *tortoiſe* cannot be deſcribed under names ſimilar to thoſe of mammiferous animals and birds, becauſe the ſhell affords inſertions to the greater number of them. We will therefore only diſtinguiſh them by their points of attachment. Thus, on viewing the back part of the neck, we remark—

1ſt. At the anterior part of the back-ſhell, near the angle of the lunula, a broad muſcle, which extends to the lateral and poſterior parts of the head into which it is inſerted. It pulls the head backward.

2d. Beneath, and from the middle of the anterior lunula of the back-ſhell, there ariſes another muſcle, which is thin and round, and which, in ſeparating from that of the oppoſite ſide, forms an angle like the letter V; it is inſerted on the outſide of the preceding muſcle, and has the ſame uſe.

3d. A muſcle analogous to the *ſplenius capitis* riſes from the ſpinous proceſſes of the fourth and fifth cervical vertebræ, by diſtinct ſlips, and is inſerted into the occipital arch. Its uſe is to raiſe the head.

4th. A muſcle analogous to the *rectus major anticus*, riſes from the inferior tubercles of the four vertebræ next to the atlas, and is inſerted, fleſhy and thick, into the depreſſion of the cuneiform proceſs below the condyle.

5th. The *trachelo-maſtoideus* riſes from the inferior tubercles of the ſecond and third cervical vertebræ, by two thin aponeurotic tendons. It is inſerted, by a very thick and entirely fleſhy portion, into the protuberance that anſwers to the maſtoid proceſs. Its uſe is to bend the head laterally.

6th. Laſtly, at the ſuperior part of the cervical ſpine there is a ſhort muſcle which proceeds from the inferior part of the foramen, formed by the temporal foſſa, and is inſerted into the ſpinous proceſſes of the firſt, ſecond and third vertebræ of the neck.

On viewing the neck in front, we obſerve the muſcle analogous to the *ſterno-cleido-maſtoideus*, attached to the ſtrong aponeuroſes that ſurround the humerus at its articulation with the ſcapula. The lower part of it, for one-third of its length, can only be ſeen, the remainder being concealed by a muſcle compoſed of tranſverſe fibres, which ſupplies the place of the *mylo-hyoideus*, and *platyſma-myoides*. It is inſerted into a proceſs correſponding to the maſtoid. Its uſe is to draw the head inwardly, and to produce a ſmall elevation of the ſhoulder.

The longus capitis ariſes from the third vertebra of the back, and is inſerted by a ſlender tendon into the cuneiform proceſs of the occiput.

The *frogs* have very few of the muſcles of the head: moſt of thoſe which are inſerted in it are employed in moving the ſuperior extremities, or are proper to the vertebral column.

The muſcle analogous to the *obliquus ſuperior* ariſes from the firſt tranſverſe proceſſes of the ſpine, and is inſerted into the ſuperior part of the occiput: its direction is oblique from without inwards.

That which is analogous to the *rectus capitis anticus minor*, ariſes from the tranſverſe proceſs of the firſt vertebra, and is inſerted into the baſis of the cranium, below the foramen magnum.

Theſe are the only two muſcles proper to the head in frogs: They are ſimilar in the *land ſalamander*.

E. *In Fiſhes.*

Oſſeous fiſhes have no particular muſcle deſtined to move the head. The lateral muſcles of the body inſerted there occaſion but little ſenſible motion; but the *rays* have three muſcles aſſigned to that purpoſe, which we think neceſſary to point out in this place. One ſerves to move the head upon the trunk, the others to raiſe and lower the extremity of the muzzle. The firſt is ſituated above the body and the cavity of the branchiæ. It is faſtened to the ſpinal column, and to the anterior portion of the bony arch that ſupports the large wings; it is inſerted into the poſterior extremity of the head, which it moves upward upon the ſpine.

With reſpect to the two muſcles of the muzzle, the ſuperior ariſes from the anterior part of the girdle, which ſupports the wings or fins by a ſhort fleſhy portion, the ſmall cylindrical tendon of which is received into a mucous ſheath: this ſheath paſſes with the tendon above the branchiæ, and extends to its inſertion at the baſe of the muzzle, which this muſcle moves upward.

The inferior is ſituated on the lower part of the body, and in the cavity of the branchiæ, whence it ariſes from the firſt cartilages of the vertebral column. It extends obliquely outward, and then inward, deſcribing a curve, the convexity of which is external. It is inſerted, almoſt entirely fleſhy, into the baſe of the ſnout, which it incurvates or bends towards the belly.

LECTURE FOURTH.

OF THE ANTERIOR EXTREMITY, OR PECTORAL MEMBER.

Article I.

Of the Bones of the Shoulder.

A. *In Man.*

The human ſhoulder is formed of two bones called the *ſcapula* and *clavicle.*

The *ſcapula,* or *omoplate,* has nearly the form of a right-angled triangle; and its ſituation, when at reſt, is ſuch that one of the ſides is parallel to the ſpine.

The longeſt ſide points obliquely outward and downward: it is called the *coſtal* margin. The ſhorteſt ſide is uppermoſt, and is called the *cervical* or *ſuperior* margin. The ſuperior, anterior, or external angle, is truncated, and forms an oval articular ſurface, on which the head of the bone of the arm moves; it is therefore called the *humeral* angle. Above this articulation there is a projection of the ſuperior margin, which is firſt directed forward, and then backward. This is called the *coracoid* proceſs.

On the convex ſurface, at about one-third of its length from the ſuperior margin downward, a proceſs is produced: this proceſs interſects the ſcapula tranſverſely, and is called the *ſpine.* It is elongated, and forms a flat detached projection, which extends over the humeral angle, and is called the *acromion.* The part of the ſurface which is above the ſpine is called *ſupra-ſpinal,* and that below it *infra-ſpinal.*

The *clavicle* is a long and ſtrong bone, with a double curvature, ſupported at one extremity on the top of the ſternum, and at the other on the acromion. The latter obeys the motions of the ſcapula, which ſlides in every direction upon the poſterior part of the ribs, to which it is not articulated, but only attached by the muſcles. Each of its margins, and each of its angles, is therefore capable of being elevated, or applied cloſer to the ribs.

The human ſhoulder, and conſequently all the reſt of the ſuperior extremity, is only articulated to the other parts of the ſkeleton, by that end of the clavical which joins the ſternum.

Certain ligaments join the ſcapula to the clavicle, and the latter to the ſternum. The firſt proceed from the coracoid proceſs, and are inſerted into the end of the clavicle next the acromion. The next are (1ſt.) the *inter-clavicular,* which connects the extremities of both clavicles behind the ſternum, and (2d.) others which ariſe from the inferior ſurface and paſſing obliquely, are inſerted into the cartilage of the firſt rib. Finally, each extremity of the clavicle is furniſhed with a capſular ligament, one attached to the acromion, and the other to the ſternum, at their articulations.

B. *In other Mammiferous Animals.*

The ſhoulder in the inferior mammalia differs from that of man, by the abſence or proportion of the clavicle, and the form of the ſcapula.

The clavicle of the Quadrumana reſembles that of man: it is entirely wanting in all animals that have hoofs, ſuch as the Pachydermata, Ruminantia and Solipeda. In animals with nails, there is nothing general to be remarked. Amongſt the Sarcophaga, the Cheiroptera, (particularly the *bats*, in which this bone is very large and ſtrong,) the Pedimana, and the greater part of the Plantigrada, namely the *moles*, *ſhrews*, and *hedge-hogs*, have it perfect; the others, that is to ſay the Carnivora, as *dogs*, *cats*, *weaſels*, *bears*, *coatis*, *racoons*, *otters*, *ſeals*, &c. have only clavicular bones ſuſpended in the fleſh, neither touching the acromion nor ſternum; and even theſe are entirely wanting in ſome individuals.

The clavicle of the *mole* is particularly remarkable on account of its thickneſs, which exceeds its length; this gives it a very ſingular ſhape. It is connected with the acromion by a ligament, and is articulated with the humerus by a broad ſurface.

With reſpect to the Rodentia, the clavicle is perfect in the *ſquirrels*, the *rats*, the *beavers*, and the *porcupines*; but is wanting in the *damans* and *cavys*. *Hares* have the clavicle ſuſpended in the fleſh.

This bone is found in ſeveral of the Edentata, ſuch as the *armadillos*, the *ant-eaters*, and the *ſloths*. In the laſt, at the ſternal extremity it is furniſhed with a proceſs which forms nearly a right angle with the axis of the bone. But the clavicle is quite wanting in the *pangolins*.

The Cetacea have no veſtige of the clavicle.

We ſee, by this inveſtigation, that the clavicle is found in all animals that often extend their arms or anterior feet forward, either to ſeize things, as the *monkey*, or to fly, as the *bat*, &c. That it is wanting in thoſe quadrupeds that uſe the anterior extremities for progreſſive motion only, and that there are rudiments of it in ſuch as hold a middle ſtate between theſe two orders.

Indeed the clavicle is a very ſtrong arch, which repreſſes the arm, and prevents it from being moved too far forward; it is, therefore, found double in birds.

The ſcapula of the *monkies* has the ſpinal angle (which anſwers to the poſterior ſuperior,) more obtuſe, and conſequently the oppoſite ſide longer than in man. This renders the ſide next the ſpine ſhorter. The ſame conformation is obſerved in the *makis*.

In the Sarcophaga the ſpinal margin, or that next to the ſpine, is rounded off, which conformation alſo renders the poſterior angle very obtuſe. The ſupra-ſpinal foſſa becomes likewiſe nearly as large, and ſometimes even larger than the infra-ſpinal. In thoſe which have no clavicles the acromion does not project ſo far, and there is another eminence pointing backwards almoſt perpendicular to the ſpine. It is alſo found in the *hedge-hogs* and Pedimana. The coracoid proceſs is, for the moſt part, wanting; it is, however, found in the *hedge-hog*, the Cheiroptera, and the Pedimana. The body of the ſcapula is elongated in the *hedge-hog*, and much more ſo in the *mole*; in the latter it appears to be a long bone, with no mark of a ſpine, except towards the poſterior margin, and before the tubercle, which correſponds to the acromion. This bone is ſo placed that it is longitudinally parallel to the ſpinal column.

The Cheiroptera alone have the ſpinal margin very long, and the poſterior angle acute.

In the Rodentia, the ſcapula has generally the ſame ſhape as in the Sarcophaga; for in them the length of the arcomion depends upon the preſence of the clavicle. The ſame rule prevails with reſpect to the length of the coracoid proceſs.—The *hares* have, upon the acromion, another long projection riſing at a right angle, and turning backward. This recurrent proceſs is very long, and rather ſlender. Towards the poſterior part it forms a very conſpicuous projecting angle.

The Ruminantia and Solipeda have the ſcapula narrow towards the back, and elongated towards the neck, like the preceding animals. The ſpine is nearer to the anterior margin, which we have named cervical or ſuperior in man. It appears truncated, and has neither acromion nor recurrent proceſs. It is likewiſe deſtitute of any coracoid proceſs.

The *hog* and the *rhinoceros* exhibit a ſtriking peculiarity in the ſpine of the ſcapula. This ſpine is almoſt effaced near the humeral angle, but about its middle there ariſes a very bold projecting proceſs, inclined towards the coſtal margin.

The ſcapula of the *elephant* is rhomboidal; the ſpine terminates in two large proceſſes, one of which turns forward and forms the acromion, and the other, which is much larger, turns backward. The latter reſembles the recurrent proceſs which we remarked in certain Rodentia, eſpecially in the *hare*.

Among the Cetacea, the *dolphin* and *porpoiſe* have the ſpinal margin of the ſcapula rounded, and very large: the ſpine is very near the cervical margin, and cannot be diſtinguiſhed from the plane of the infra-ſpinal foſſa. The ſupra-ſpinal foſſa has a deep hollow, that ſeems to proceed from a defect in the oſſification. Above the humeral angle there is a projecting plate, which is continued with the ſpine, and ſeems to correſpond to the acromion. In the other mammalia of this family the foſſa ſupra-ſpinalis is ſtill leſs diſtinct.

We find that the extent of the ſcapula, in the direction parallel to the ſpine, is in proportion to the violence of the efforts the animal has to make with the anterior members; becauſe this configuration affords more extenſive attachments for the muſcles that connect it with the trunk. Thus, in *man*, in *monkeys*, and more particularly in *bats* and *moles*, it approaches neareſt to that extreme elongation which prevails in birds.

C. *In Birds.*

In birds the ſhoulder is compoſed of three bones, the *clavicle*, the *fork*, and the *ſcapula*.

The *clavicle* is a ſtraight large bone, flat before and behind. It is articulated by a large and ſharp head, with the anterior edge of the ſternum in a correſponding hollow, in which it has but little motion. It advances forward, and ſomewhat laterally; it is then enlarged, and divided into ſhort proceſſes. The firſt proceſs, which is anterior, inferior, and internal, is connected to the fork; the ſecond, which is poſterior, ſuperior, and external, is articulated to the ſcapula, and with it forms a cavity into which the head of the humerus is received.

The *ſcapula* is elongated in the direction parallel to the ſpine, and is very narrow on the oppoſite ſide. It is often pointed, but ſometimes truncated on the poſterior part, and always flat and deſtitute of a ſpine. The head, or humeral extremity, becomes thicker at its junction with the clavicle. Outwards we obſerve the ſurface which theſe bones in common preſent to the head of the humerus, and inwardly a little point which anſwers to the extremity of the fork. Between theſe three bones, however, there is ſtill left a ſmall vacancy or free ſpace.

The *fork*, or *os furciforme*, is ſingle, and common to both ſhoulders. It is elaſtic, and ſhaped like a V. Its point is turned backwards, and its two branches ſupport the humeral heads of the two clavicles. By its elaſticity it hinders them from cloſing together in the violent efforts of flying.

Birds of prey that fly by day have the fork very ſhort, with crooked branches; their convexity is forward, and the angle of union round, and ſeparate from the ſternum.

Nocturnal birds of prey have the fork weak, with almoſt ſtraight branches, the angle obtuſe and cloſe to the ſternum.

In *parrots* it is alſo weak; the branches are convex outward, and the angle of union obtuſe, and removed from the ſternum.

In the Paſſeres the bone is nearly of a parabolic figure, with the angle cloſe to the ſternum. However, the *ſwallow* and the *goat-ſucker* muſt be excepted, as they have it ſmall, like birds of prey.

The Gallinæ have it alſo nearly parabolic. The angle is prolonged in a proceſs from which a ligament proceeds to faſten it to the keel of the ſternum, which in theſe birds is very low.

The *ducks*, *merganſers*, and *flamingos*, have the fork reſembling birds of prey.

In the *herons* and *cormorants*, the angle of the fork is articulated with the ſummit of the keel of the ſternum. It is united to it by oſſification in the *cranes* and *ſtork*, the *jabiru* and *pelican*.

The two branches of the fork are ſeparate in the *oſtrich*, and each anchyloſed with the clavicle and ſcapula of the ſame ſide. Theſe three, therefore, form only one very flat bone, with an opening near the extremity, by which it is joined to the ſternum.

In the *caſſowary* no fork can be found except a ſort of proceſs at the internal border of the head of the clavicle, which is merely a rudiment.

Thus we ſee that the os furciforme is the more detached, ſtronger, and more elaſtic in proportion to the activity of the bird in flying, and the neceſſity of the functions of that bone. But in thoſe birds which never fly it can ſcarcely be ſaid to exiſt, and, at beſt, it is far from being able to ſeparate, by its reſiſtance, the heads of the clavicles: in fact, there remains, in birds of this kind, only the veſtige of it.

D. *In Reptiles.*

In oviparous quadrupeds the glenoid cavity of the ſhoulder is partly compoſed of the ſcapula, and partly of the clavicle.

The ſcapula, which is elongated, has no ſpine: it contracts, and becomes thicker towards the neck.

The clavicle is ſimple, ſhort, and flat, and united to the ſternum in the *crocodile* and *lizards*. It is broad, and almoſt ſquare, in the *iguana* and *camelion*. In the *tupinambis* it is oval, and very large and long between the front and back, and has two unoſſified parts.

The *frog* and *toad* have two clavicles to each ſhoulder, attached to the two extremities of the ſternum. The ſcapula is bent, and compoſed of two articulated pieces, with the ſuperior one inclining towards the ſpine. The ſame conformation obtains in the *Surinam toad*. The anterior clavicles appear to correſpond to the os furciforme of birds. The clavicle, the ſternum, and the firſt piece of the ſcapula, are anchyloſed together.

The *ſalamanders* have the ſhoulder formed in a moſt ſingular manner. The ſcapula, clavicle, and ſternum conſiſt only of a ſingle bone, which receives the head of the humerus. The ſhoulder is almoſt all cartilaginous; but the part anſwering to the ſcapula is more diſtinct than the reſt. It inclines towards the ſpine, where it receives the muſcles by which it is moved. The clavicular part is directed towards the head; that which ſupplies the place of the ſternum turns towards the breaſt, but without uniting with the bone of the oppoſite ſide: the part on the right ſide ſlides over that on the left. This conformation allows a greater dilatation of the breaſt in reſpiration.

The *tortoiſe* has alſo theſe three bones, which unite to form the glenoid cavity, and correſpond with the ſcapula fork and clavicle. But as their reſpective diſpoſition is very remarkable, it appears neceſſary to give a particular deſcription of them.

One of the bones extends from the baſe of the rudiment of the firſt rib, to which it is fixed by a ligament, as high as the humeral cavity, where it is intimately connected with the other two.

The ſecond bone may be conſidered as the continuation of the firſt, which it joins at the humeral cavity, of which it forms part. Its other extremity is attached to the breaſt-plate, and ſtrong ligaments likewiſe unite this extremity to that of the poſterior bone.

Theſe two bones, thus united, are ſlightly bent outwards, ſo as to leave between them and thoſe of the oppoſite ſide, an oval ſpace, through which the œſophagus, the trachea, and ſeveral muſcles, paſs.

The firſt ſeems to correſpond to the clavicle, and the ſecond to the os furciforme.

Finally, the third bone of the ſhoulder is ſituated below the abdominal and thoracic viſcera, nearer the breaſt-plate. It is long, and extends from the humeral cavity, of which it forms the lower part, as far as the abdomen. It ſeems to ſupply the place of the ſcapula, by the number of muſcles inſerted into it; but its ſituation is juſt the reverſe of that bone. A very ſtrong ligament unites this bone to the ſecond.

N. B. As the pectoral member in fiſhes cannot, in any manner, be compared to that of the other vertebral animals, it ſeemed neceſſary to give a particular deſcription of it, which will be found at the end of this Lecture.

ARTICLE II.

Of the Muſcles of the Shoulder.

A. *In Man.*

THE human ſhoulder is moved by ſeveral muſcles, which give to it four principal motions that are often combined together. In one of theſe motions the ſhoulder is brought forward towards the breaſt. In the ſecond, which is the reverſe of the former, it is drawn back in the contrary direction, and the back becomes covered. In the third, the ſhoulders are pulled downward, and retained in that poſition. The neck is then at eaſe. By the fourth, the ſhoulders are raiſed towards the head, or elevated.

These muſcles are eight in number.

1. THE SERRATUS MAJOR ANTICUS, *or* COSTO-SCAPULARIS,

Is attached inferiorly to the ſpinal margin of the ſcapula. It then expands, and is inſerted by digitations into the external ſurface of the ribs from the firſt to the ninth. By its inferior digitations, this muſcle pulls the ſhoulder, at the ſame time, downward and forward; by the ſuperior digitations, it draws it upward, or towards the head; and finally, by its middle portions, it holds the ſhoulder fixed in a forward poſition.

2. THE PECTORALIS MINOR, SERRATUS MINOR ANTICUS, *or* COSTO-CORACOIDEUS.

This muſcle is inſerted, at one end, into the coracoid proceſs, and at the other, by three digitations, into the anterior ſurface of the three ribs, from the third to the fifth. The obliquity of its fibres determines the motion of the humeral angle of the ſcapula downward, and at the ſame time moves it forward.

3. THE LEVATOR SCAPULÆ, ANGULARIS SCAPULÆ, *or* TRACHELO-SCAPULARIS,

Is inſerted into the poſterior and ſuperior angle of the ſcapula. It proceeds towards the neck, where it is inſerted, by fleſhy ſlips, into the tranſverſe proceſſes of the vertebra, from the ſecond to the fifth. It raiſes the ſcapula behind, while at the ſame time it ſomewhat depreſſes the humeral angle, as this bone then becomes a kind of lever.

4. THE OMO-HYOIDEUS, CORACO-HYOIDEUS, *or* SCAPULO-HYOIDEUS,

Extends from the ſuperior coſta of the ſcapula, near the coracoid proceſs, to the baſe, and up to the horns of the os hyoides, into which it is inſerted. Its uſe is to pull down the os hyoides a little. It aſſiſts deglutition, more than it contributes to the motion of the ſhoulder.

5. THE TRAPEZIUS, CUCULARIS, *or* DORSO-SUB-ACROMIALIS,

Has its inſertions, on one part, in the occipital arch, and all the ſpinous proceſſes, as well cervical as dorſal; and, on the other, is inſerted into the whole length of the ſpine of the ſcapula, and part of the clavicle. This muſcle, like the ſerratus magnus, acts in oppoſite directions in its partial contractions: thus the ſuperior portion raiſes the ſhoulder, the middle draws it backward, and the lower pulls it downward.

6. THE RHOMBOIDES, *or* DORSO-SCAPULARIS.

This is ſituated under the preceding muſcle. It ariſes from the ſpinous proceſſes of the fifth, ſixth, and ſeventh cervical, and the four firſt dorſal vertebræ; it is then inſerted into the ſpinal edge of the ſcapula below its ſpine. It's direction is oblique, and it tends outward as it deſcends. This muſcle ſeems calculated for moving the ſcapula backward, while at the ſame time it raiſes it a little, in conſequence of the aſcending obliquity of its fibres.

7. THE SUBCLAVIUS, *or* COSTO-CLAVIUS,

Is ſituated below the clavicle, occupying, in an oblique direction only, the ſpace between that bone and the firſt rib. It fixes the clavicle to the breaſt in the violent exertions of the ſhoulder.

8. THE STERNO-CLEIDO-MASTOIDEUS.

This muſcle, which we have already deſcribed in treating of the motions of the head, may likewiſe be included in thoſe of the ſhoulder, on account of the action of that part which is inſerted into the clavicle; but the motion it produces is very confined.

B. *In other Mammiferous Animals.*

The *ſerratus major* is more extenſive in the inferior mammalia than in man; for it is attached, by digitations, not only to the ribs, but to the tranſverſe proceſſes of the cervical vertebræ. This is neceſſary in animals which walk upon all fours, to prevent, more effectually, the ſcapula from being preſſed towards the ſpine. This muſcle, with its correſpondent one, forms a ſpecies of girth that ſupports the thorax. As it has the ſame extent in *monkeys*, it is one proof that nature intended them to uſe all the four feet in walking. The ſerratus major in them even furniſhes digitations to all the cervical vertebræ; while, in ſome of the carnivora, the digitations extend only to a part of theſe vertebræ. In the *cat*, for inſtance, there are four digitations; the *dog*, the *bear*, and the *rabbit*, have five. In the *dolphin*, (which does not walk,) the ſerratus major has no inſertions in the vertebræ of the neck.

The *pectoralis minor* is wanting in the carnivorous and hoofed animals. The *horſe* has a muſcle which ſupplies its place; it riſes, by digitations, from the ribs; it then paſſes to the anterior edge of the ſcapula, but in its way it unites itſelf with the fibres of the pectoralis major, ſo as to be inſerted partly into the humerus. In the *dolphin*, its place is ſupplied by a muſcle, which has only one digitation inſerted into the ſternum, near to the anterior extremity; above, it is attached to the humeral cavity of the ſcapula.

The *levator ſcapulæ* preſents many varieties in the number and inſertions of its tendons. For inſtance, in *monkeys* it is not inſerted into the angle, but into the ſpine of the ſcapula, near the acromion, and it is then covered by the trapezius which is not divided. In the Carnivora, and the Rodentia, it occupies a larger compaſs. It approaches ſtill nearer to the humeral extremity of the ſpine of the ſcapula, and the trapezius being bifid, it paſſes between the two parts. In the *cat*, it has only two ſuperior attachments, one into the tranſverſe proceſs of the firſt vertebra of the neck, and the other into the cuneiform proceſs of the occipital bone.

In the *dog* and the *bear*, it is inſerted only into the firſt vertebra of the neck; in the *rabbit*, it is attached to the cuneiform, or baſilar proceſs of the occiput only. *Vicq. D'Azyr* has conſidered this as a diſtinct muſcle, and has called it ACROMIO-BASILARIS.

In the *ſheep*, it riſes from the firſt cervical vertebra, and is inſerted into the poſterior part of the ſpine of the ſcapula. It is entirely wanting in the *horſe*.

In the *dolphin*, it is faſtened to the tranſverſe proceſs of the firſt vertebra, but its tendon is expanded over the whole external ſurface of the ſcapula.

The *trapezius*, and *ſterno-cleido maſtoideus* of the *monkey*, very much reſemble thoſe of man, but in the other mammiferous animals they are ſo complicated, that we are obliged to deſcribe them together.

In ſuch of the Sarcophaga, and the Rodentia, as have not the clavicle perfect, the *cleido-maſtoideus* (which is very diſtinct from the *ſterno-maſtoideus*), and the clavicular portion of the *deltoides*, not being ſeparated by a fixed bone, form together only one muſcle, acting upon the humerus; this might be named MASTO-HUMERALIS. The clavicular portion of the *trapezius* likewiſe joins them at their point of union, and theſe three portions form one muſcle, called by anatomiſts COMMUNIS CAPITIS, PECTORIS, et BRACHII. This clavicular portion of the trapezius is very diſtinct from its ſcapular part. It is even ſeparated from it by the levator ſcapulæ, which paſſes between them. It is more or leſs extended according to the ſpecies.

Thus we find that in the *dog* and the *cat* its fibres proceed partly from the cervical ligament. In the *rabbit*, there are none but what come from the occiput. In the *bear*, the anterior portion of the *trapezius* is again ſubdivided into two muſcles. The fibres, which come from the occiput, form a tendon which is inſerted into the ſternum, at the ſame place as the ſterno maſtoideus.

In the *ſheep*, one tendon only proceeds from the maſtoid proceſs, which preſently divides into two muſcular faſciuli: one of theſe goes to the ſternum; and the other, which correſponds with the *cleido maſtoideus*, is confounded with the clavicular part of the *trapezius*, almoſt oppoſite to the midde of the neck, and forms, with that and the clavicular portion of the *deltoides*, a ſingle muſcle, extending to the humerus, as in the preceding ſpecies.

In the *horſe*, there is only what is called in man, the aſcendant portion of the *trapezius*, which is inſerted into the poſterior part of the ſpine of the ſcapula. There is alſo a *ſterno-maſtoideus*; but inſtead of the *levator*, the *cleido-maſtoideus*, and the clavicular portions of the *trapezius* and *deltoides*, we only find a ſingle muſcle attached to the maſtoid proceſs, and the tranſverſe proceſſes of ſome of the ſuperior cervical vertebræ, which paſſes before the head of the humerus. This muſcle deſcends along the internal ſurface of the arm, to be inſerted inferiorly.

The *dolphin* has not the clavicular portion of the *trapezius*. This muſcle which is itſelf very thin, covers all the ſcapula, and is inſerted near its neck. The *ſterno-maſtoideus* is very thick, with a large belly; and on the outſide of it there is another muſcle, much ſimilar, which riſes from the maſtoid proceſs, and is inſerted below the head of the humerus.

We have ſtill to deſcribe a thin muſcle belonging to this part in the *rabbit*. It ariſes from the ſpine of the ſcapula, covering the ſupraſpinalis, and is inſerted into the clavicle.

The *rhomboides* in *apes* extends as far as the occiput. Its occipital fibres, which in them are ſometimes divided from each other, are always ſeparate in carnivorous animals, and then form a particular muſcle, named by anatomiſts OCCIPITO-SCAPULARIS, or LEVATOR SCAPULÆ MAGNUS.

In the *horſe*, this anterior portion of the *rhomboides* is inſerted into the cervical ligament only. This is the LEVATOR SCAPULÆ PROPRIUS of hippotomiſts.

The *rhomboides* is ſmall in *dolphins*, and has no diſtinct anterior portion.

The *coraco-hyoideus* has nothing remarkable in *monkies*. It is wanting in animals that have no clavicle or coracoid proceſſes: even in dogs there is none.

The *ſubclavius* alſo exhibits nothing remarkable in monkies; it is wanting in the mammalia that have no clavicles.

It is neceſſary to give a particular deſcription of the muſcles of the ſhoulder in the *mole*, on account of their ſingularity.

The cervical portion of the *ſerratus major* is ſimple, exceſſively large and turgid, and is only attached to the laſt vertebra. Inſtead of the whole *trapezius*, there are only two bundles of fibres, which proceed from the loins, and are inſerted into the poſterior extremities of the ſcapula. Theſe two faſciculi being almoſt parallel, would rather pull the extremities aſunder than bring them together, were they not connected by a very ſtrong tranſverſe ligament. The uſe, therefore, of theſe two muſcular faſciculi is to give to the whole anterior part of the body a kind of balance-like motion in an upward direction.

The *rhomboides* has almoſt all its ſcapular attachments at the ſame tranſverſe ligament which is common to the two ſcapulæ. Its other inſertion is in the cervical ligament, which is always oſſified. Its uſe is, therefore, to raiſe the head with much force.

This renders the muſcle which is analogous to the occipital portion more effectual. Its fibres are parallel to the ſpine; they paſs through thoſe of the rhomboides, properly ſo called, to be attached to the tranſverſe ligament; the anterior extremity is inſerted into the middle of the cranium.

The *ſterno* and *cleido maſtoidei* have nothing particular, and the *levator ſcapulæ* is wanting.

The *pectoralis minor* is very thin; it is inſerted into the anterior part of the firſt ribs, and into the ligament that connects the clavicle to the ſcapula.

The clavicle has two muſcles: one, which may be called *ſuperclavius*, ariſes from the firſt bone of the ſternum, at the anterior angle of the great head of the clavicle; the other alſo ariſes from the ſternum, but lower down, and is inſerted near the firſt.

We ſhall likewiſe particularly deſcribe the motion of the ſhoulder in the *bat*, ſince it widely differs from that of the other mammalia.

The *ſerratus major* is ſituated before the pectoralis minor: it is attached to all the ribs, but not to the neck, and is inſerted into the external and inferior border of the ſcapula.

The *ſubclavius* is only remarkable for its bulk, which is comparatively very conſiderable.

The *pectoralis minor* has three digitations; it is inſerted into the coracoid proceſs, which is very ſtrong, by a broad tendon.

The *trapezius* is neither attached to the ſpine nor the proceſſes of the neck, but to the eleven firſt dorſal vertebræ; it is inſerted into the triangular ſurſace of the cervical angle of the ſcapula.

The *rhomboides* has no peculiarity.

The *levator ſcapulæ* ariſes from the fifth and ſixth vertebræ of the neck.

The *ſterno-maſtoideus* is not attached to the clavicle.

C. *In Birds.*

The ſcapula of birds is moved by four muſcles analogous to thoſe of the mammalia: but in general thoſe of the upper part are very ſmall and ſlender; they are neither attached to the head nor the neck. This conformation is probably connected with the length and flexibility of the neck.

The *ſerratus major*, or SUBSCAPULARIS of *Vicq. D'Azyr* is divided into four or five flat ſlips, which ariſe from the one half of the inferior coſta of the ſcapula next its free extremity, and which are inſerted into the five firſt ribs. The firſt is almoſt parallel to the ſpine; the ſecond is more oblique; the three laſt are thick, and paſs directly towards the ſpine, or, in other words, are perpendicular to it.

The COSTO-SCAPULARIS of *Vicq. D'Azyr* is a muſcle which might be taken for a ſlip proceeding from the ſerratus major; but it ariſes from the lower coſta of the ſcapula more forward, and deſcends to be inſerted into the firſt ribs.

The *trapezius* is compoſed of two portions; one ariſes from the ſpinous proceſſes of the laſt vertebra of the neck and the firſt of the back, and paſſes on towards the inferior and interior branch of the fork. The other part is much longer, it adheres to all the ſpinous proceſſes of the back except the firſt, and, paſſing obliquely forwards, is inſerted into the ſuperior, or ſpinal edge of the ſcapula.

The *rhomboides* is partly covered by the trapezius, and immediately by the latiſſimus dorſi: it likewiſe riſes from the ſpinous proceſſes of the dorſal vertebra, and is inſerted into the moſt poſterior part of the ſpinal margin of the ſcapula.

D. *In Reptiles.*

In the *frog* (which has no ribs) the *ſerratus major* has an extraordinary ſhape, which appears to be occaſioned in part by the want of the cervical vertebræ: it forms three diſtinct muſcles.

The firſt ariſes from the occiput, near to the foramen magnum. It divides into two bellies, which are inſerted into the ſuperior ſpinal angle of the ſcapula; one on the internal, and the other on the external ſide.

The ſecond proceeds from the ſecond tranſverſe proceſs, and paſſes under the dorſal portion of the ſcapula, towards its ſpinal edge.

The third proceeds from the third tranſverſe proceſs, and paſſes underneath the preceding, keeping ſtill nearer to the edge.

There is beſides another muſcle proper to the ſcapula, ſituated upon its internal ſurface, between the two conſtituent parts, which make it appear broken. It appears to draw theſe two parts cloſer together, and by its contraction renders the angle they form with each other more acute.

There is no muſcle analogous to the *pectoralis minor*.

The place of the *levator*, or *angularis ſcapulæ*, is ſupplied by a very conſiderable muſcle which riſes from the baſe of the occiput; it becomes perceptibly ſmaller as it approaches the ſhoulder, and is inſerted into the poſterior edge of the cartilaginous part of the ſcapula.

The *omo-hyoideus* is long and thin; it comes from the great inferior horn of the os hyoides, and is inſerted under the neck of the ſcapula.

The *trapezius* is wanting.

The muſcle analogous to the *rhomboides* is very thin. It ariſes from the dorſal proceſſes, and is inſerted into the ſpinal edge of the ſcapula.

There is no *ſubclavius* muſcle.

The *ſterno-maſtoideus* has only one belly, which extends obliquely from the poſterior part of the head, behind the ear, to the neck of the oſſeous part of the ſcapula. Its action is evidently that of pulling the ſhoulder towards the head, and raiſing it up.

We ſhall deſcribe the muſcles of the *tortoiſe* ſeparately, as they differ conſiderably from thoſe of other red-blooded animals. They are only three in number.

One of them, though very unlike the *trapezius*, is ſimilar in its uſe. It riſes from the lower ſurface of the back-ſhell among the ribs, from the ſecond to the fifth. It is very thin, and paſſes to the external margin of the third bone of the ſhoulder, which ſeems to correſpond with the ſcapula.

A muſcle analogous to the *levator ſcapulæ*, is inſerted into the curve, formed by the joint of the two firſt bones of the ſhoulder. It ariſes by ſeven fleſhy heads from the tranſverſe proceſſes of the ſeven vertebræ of the neck.

Another little long muſcle ariſes from the inner ſurface of the back-ſhell near the ſternal extremity of the firſt rib, and is inſerted into the dorſal extremity of the firſt bone of the ſhoulder. It is perhaps analogous to the *coſto-clavius*.

ARTICLE III.

Of the Bone of the Arm.

A. *In Man.*

THE arm is formed of a ſingle bone, called the *humerus*, which is joined to the ſhoulder and fore-arm. It is received, at one end, into an articular cup belonging to the ſcapula, in which it moves in every direction. It is a long bone, but we ſhall only here conſider its ſuperior articulation, or ſcapular extremity. It terminates in a rounded convex and oblique portion, called the *head* of the humerus. This part is diſtinguiſhed from the reſt of the bone by a little circular depreſſion called the *neck*. There may be likewiſe obſerved two proceſſes, but not very prominent. The poſterior one, on account of its being larger, is called the *great tuberoſity*, *(trochiter ;)* the anterior, being leſs, is called the *little tuberoſity*, *(trochin.)* The ſeeminences are ſeparated by a ſort of canal, or longitudinal groove, in which the tendon of the *biceps*, or *ſcapulo-radialis* muſcle, ſlides. The head of the humerus is retained in the articular cavity of the ſcapula by a ligamentous capſule, which riſes from the bony and cartilaginous edges of the cavity, and extends to the neck of the humerus. The tendon of the biceps muſcle, which penetrates into this articulation, produces, likewiſe, the effect of a ligament. The middle part of the bone is nearly cylindrical; but there are ſome eminences towards the ſcapular extremity, for the inſertion of muſcles. The bone becomes longer and flatter toward the cubital extremity, which we ſhall explain in treating of the articulation of the fore-arm.

B. *In other Mammiferous Animals.*

In all claſſes of animals whatſoever the humerus is ſimple. It varies little in its form;

and as to its proportion with the reſt of the anterior extremity, we may remark, that, in the mammalia, it is ſhorter according as the metacarpus is longer. In the animals that have *cannon bones*, or a cylindrical metacarpus, the humerus is almoſt entirely concealed under the ſkin of the thorax. It is very long, in proportion to the body, in *bats* and *ſloths*.

The *guenons* have the humerus more arched towards the back part than man. Its ſpines are ſo ſharp that its ſuperior part becomes a triangular priſm. The great tuberoſity riſes much above the head of the bone.

In the *pongo* and the other *monkies*, it reſembles the ſame bone in man, but is ſometimes longer or ſhorter.

The large Sarcophaga have the humerus arched, with the head elevated conſiderably above the axis of the bone. The great tuberoſity is very broad, flat, and riſes above the head.

The reſt, and the Rodentia, and Edentata, alſo exhibit no difference that is very perceptible, except in the proportional length of the bone, and the elevation of its ſpines. In the *beaver*, for example, it is much enlarged at the cubital extremity, and bears, at about one third from the top, a large tranſverſe proceſs. Its figure is triangular.

In the *hog*, the *tapir*, and the *rhinoceros*, the great tuberoſity is divided into two parts. The linea aſpera in the laſt, is terminated below by a very high tubercle.

It is likewiſe found, though ſmaller, in the *horſe*, in which the little tubercle has alſo a channel.

The Ruminantia, in general, have the great tuberoſity very high, and the linea aſpera very prominent. In the *camel* the little tuberoſity is the higheſt, and hollowed out into a canal.

In the Cetacea the humerus is extremely ſhort, rounded at the top, and has, on its external ſurface, a ſmall tuberoſity.

The Mole has the moſt ſingular humerus of all mammiferous animals. It is not only articulated to the ſcapula by a little head, but by another, which ſeems to appertain to the great tuberoſity, with a ſurface upon the clavicle. Between the latter and the head of the bone there is a deep hollow. The creſt of the little tuberoſity is ſo large that it reſembles a ſquare placed vertically, with the linea aſpera at top. The reſt of the body of the bone, which is very ſhort, is bent towards the top, ſo that the part which articulates with the fore-arm points directly upward. From this conſtruction it follows that the elbow is elevated above the ſhoulder, and the palm of the hand turned outward, which is neceſſary for the mode of life of this animal.

C. *In Birds.*

The humerus in birds is articulated at once with the ſcapula and clavicle by an eminence reſembling a portion of a wheel, which is ſituated almoſt in the plane of the two ſpines. Behind the internal ſpine, under the head of the bone, there is a deep cavity. The external ſpine is thin, and very prominent; the internal is ſhorter, and more obtuſe.

In general, the humerus is cylindrical in birds, towards its middle part, except in the *manchot*, which has it ſo ſingularly compreſſed from left to right, that, at its radial extremity, the two bones of the fore-arm are articulated one over the other in the ſame line.

In the *oſtrich* the humerus is very long, and curved in the direction of the curvature of the ſides. It is very ſhort in the *caſſowary*.

D. *In Reptiles.*

The humerus of the *tortoiſe* has a very remarkable ſhape. As in birds, it is articulated at once to the ſcapula, clavicle, and os furciforme, by a large oval head, the greateſt diameter of which lies in the direction of the flatneſs of the bone. A conſiderable eminence riſes above this large head, which, by its curvature and its uſes, has ſome relation to the olecranon—a proceſs which, in this animal, the bone of the fore-arm wants. Below the head there is another eminence, leſs projecting, but more rough, which likewiſe ſerves as a point of inſertion to ſome muſcles, and ſupplies the place of the little tuberoſity. The reſt of the body of the bone is flatted and narrowed towards the middle.

In the *crocodile*, the humerus is round, but a little bent like an S in its whole length. At the extremity that joins the ſcapula, it reſembles the *tibia*: Its head, inſtead of being round, is flat; and its tuberoſity, which is ſingle, is anterior, in the form of a ridge, and ſomewhat inclined inwards.

In the other *lizards*, and in *frogs*, the humerus exhibits nothing peculiar.

Serpents, having no limbs, have conſequently no humerus.

ARTICLE IV.

Of the Muſcles of the Arm.

A. *In Man.*

THE human humerus is put in motion by muſcles, of which ſome ariſe from the trunk, and others are attached to the ſcapula.

The former are:

1. THE PECTORALIS MAJOR, *or* STERNO-HUMERALIS.

It riſes from the ſternum, the ſternal portion of the clavicle, and the ſeven firſt ribs. It covers the breaſt in front, and is inſerted into that part of the linea aſpera which forms the exterior border of the bicipital groove. It brings the humerus forwards and inwards in whatever poſition it may be. It alſo turns it round upon its own axis.

2. THE LATISSIMUS DORSI, *or* LUMBO-HUMERALIS.

This muſcle extends from the os ſacrum, the creſt of the os ilium, the ſpinous proceſſes of the lumbar vertebræ, the ſeven laſt dorſal vertebræ, and the four laſt vertebral ribs, to the poſterior and inferior part of the ſmall tuberoſity of the humerus, below which its tendon is inſerted, broad and thin. This muſcle covers the back part of the trunk; its uſe is to move the humerus backward, and ſomewhat downward.

The latter are divided into two kinds.

a. Thoſe which ariſe from the ſurface of the ſcapula.

1. THE SUPRA-SPINATUS, *or* SUPRA-SCAPULO-TROCHITERUS,

Is ſituated in the ſupra-ſpinal foſſa. Its tendon paſſes above the articulation, and is inſerted into the great tuberoſity of the humerus, which it elevates.

2. THE INFRA-SPINATUS, *or* SUB-SCAPULO-TROCHITERUS.

This muſcle occupies the foſſa below the ſpine. Its tendon is inſerted into the anterior ſurface of the head of the humerus, which it rolls outward upon its axis.

3. THE SUB-SCAPULARIS, *or* SCAPULO-TROCHINEUS,

Is attached to the whole coſtal ſurface of the ſcapula, and its tendon is inſerted into the little tuberoſity of the humerus, which it rolls inward upon its axis, and draws it at the ſame time towards the body.

b. Thoſe which ariſe from the eminences of the ſcapula:

1. THE DELTOIDES, *or* SUB-ACROMIO-HUMERALIS.

This muſcle ariſes from the whole inferior edge of that half of the clavicle next to the ſcapula, from the acromion, and part of the ſpine of the ſcapula. It is compoſed of ſeveral penniform and radiated bellies, uniting in one common tendon, which is inſerted into the internal linea aſpera of the humerus, about one-third of its length from the ſcapula, and more outwardly than the pectoralis major. It is the moſt powerful elevator of the arm.

2. THE TERES MINOR.

This ſeems to be a portion of the infra-ſpinatus. It riſes from the inferior edge of the ſcapula, and is inſerted into the external ſurface of the head of the humerus.

3. THE TERES MAJOR, *or* SCAPULO-HUMERALIS,

Ariſes from the inferior or coſtal angle of the ſcapula, and paſſes ſomewhat below the head of the humerus to its internal ſurface. Its actions accord with thoſe of the preceding muſcles.

4. THE CORACO-BRACHIALIS, *or* CORACO-HUMERALIS,

Extends from the coracoid proceſs, where it riſes by a tendon common to it and the coracoidal head of the biceps, to the middle of the humerus, in the direction of which it paſſes along its internal ſurface. This muſcle raiſes the arm towards the ſhoulder, and in ſome caſes may move the ſcapula upon the arm.

B. *In other Mammiferous Animals.*

All the muſcles of the humerus are found in the mammalia, but with ſome modifications.

The *pectoralis major* is generally more fleſhy than in man, and compoſed of more diſtinct faſciculi.

In *monkies* the clavicular portion extends to the linea aſpera, and alſo lower down. The fibres of the ſternal portion paſs in three diviſions.

There are beſides two coſtal portions; one anterior and greater, which is inſerted into the great tuberoſity; the other poſterior and leſs, which is inſerted into the neck of the bone below the head. This muſcle, therefore, ſeems to be compoſed of three, four, or five others.

In the mammalia that have not the clavicle perfect, and in the *dolphin* alſo, there is firſt a ſternal portion, which runs perpendicularly to the linea aſpera, forming with its fellow on the oppoſite ſide a muſcle common to both arms; it is this which produces the croſſing of the four legs: it may be called, AMBIBRACHIALIS COMMUNIS.

In the Carnivora, in general, this muſcle is ſubdivided into ſeveral portions, part of which is extended to the lower part of the humerus, tending very obliquely backward. This common muſcle is alſo found in the Ruminantia. The *ſheep* has, beſides, a ſecond *muſculus communis*, totally different, which extends from the ſternal region to the cubitus, and thus completely encloſes the humerus in the trunk. It ſeems to have more relation to the panniculus carnoſus than to the pectoralis major. In the *horſe*, this latter is called by hippotomiſts the *ambibrachialis communis*, and produces a kind of croſſing of the fore legs.

A ſecond portion of the *pectoralis major* is much larger, and more deeply ſeated than the common muſcle, ariſes from the whole length of the ſternum, and paſſing obliquely, is inſerted near the humerus; even this is ſometimes divided into ſeveral faſciculi.

The *latiſſimus dorſi* of quadrupeds differs but little from the human, but thoſe animals have one muſcle more; for the *panniculus carnoſus*, or *cutano-humeralis*, produces a very remarkable tendon, which is inſerted into the humerus, cloſe by that of the latiſſimus dorſi. It unites with the tendon of the teres major, and affords an attachment to one of the portions of the extenſor cubiti.

In the *dolphin*, there is a little muſcle, the direction and uſe of which appears to be the ſame with thoſe of the *latiſſimus dorſi*; but it ariſes by digitations from the ribs. It is entirely covered by the dorſal part of the panniculus carnoſus.

The *ſupraſpinatus*, *infraſpinatus*, *ſubſcapularis*, *teres major* and *teres minor* muſcles, differ from thoſe of mankind no otherwiſe than in their proportion, which correſponds with the figure of the ſcapula.

The *ſupraſpinatus* is generally larger than the *infraſpinatus*; the contrary occurs in man.

In the *dolphin*, theſe muſcles, except the *ſubſcapularis*, are indiſtinct and nearly obliterated.

It has already been ſhewn, that in animals which have not the clavicle perfect, the clavicular portion of the *deltoid* is united to that of the *trapezius*. We have now, therefore, only its ſcapular portion to deſcribe.

This ſcapular portion ſeems itſelf divided into two parts; one proceeding from the acromion, and the other from the ſpine, or, more frequently, from the infra-ſpinous portion of the ſcapula. They unite, intermix croſſways, and form a common tendon, which is inſerted into the linea aſpera of the humerus.

In the *ſheep* the acromial part is very ſmall, and there is none at all in the *horſe.* The *deltoides*, therefore, which in this animal takes the ſame direction as the infra-ſpinatus, is called the ABDUCTOR LONGUS BRACHII.

The *coraco-brachialis* exiſts even in thoſe animals that have no coracoid proceſs, and ariſes from a little eminence of the ſuperior border of the ſcapula. Its tendon is common with that of the head of the biceps, which riſes from the coracoid proceſs in thoſe which have the biceps really with two heads.

Monkies have the *coraco-brachialis* divided into two portions, the inferior of which extends the whole length of the poſterior and internal ſurface of the humerus.

In the *bear* the inferior portion is ſlender, and proceeds to be inſerted at the external condyle. It ſends off, from its middle, a ſlip which joins the biceps, and reſembles its coracoid head.

In the *dog*, the *cat*, the *rabbit*, and the *horſe*, the *biceps* has only one head, and the *coraco-brachialis* conſiſts only of one part, which is totally unconnected with the biceps.

In the *mole*, the *pectoralis major* is of an extraordinary thickneſs, and almoſt as large as in birds. It is compoſed of ſix portions, all inſerted into the anterior ſurface of the ſquare part of the humerus. Four of theſe portions ariſe from the ſternum, and are inſerted into different edges and angles of this ſquare ſurface; the fifth riſes from the ſternum, and covers the whole ſurface; and finally, the ſixth proceeds tranſverſely from one humerus to the other.

The *latiſſimus dorſi* is conſiderable. It is divided into two portions, and inſerted into the poſterior ſurface of the ſquare part of the humerus. The *teres major*, which is inſerted at the ſame place, is of an enormous bulk. It is by the means of theſe three muſcles that the animal is enabled to dig and puſh the earth backward. The other muſcles of the humerus exhibit nothing ſingular in the *mole*, except what ariſes from the peculiar figure of the bones.

In the *bat*, the muſcle analogous to the *pectoralis major* is compoſed of three portions, or rather of three diſtinct muſcles.

One, ſituated as uſual, extends from the ſalient line of the ſternum to the head of the humerus, which it covers, and is inſerted into the great anterior tubercle.

The ſecond riſes from the whole length of the clavicle and the anterior part of the ſpine of the ſternum. It is inſerted behind the great tubercle, above the preceding, and aſſiſts its action in the motions of the wing.

The third is partly covered by the firſt: it ariſes from the laſt ribs, near their ſternal cartilages.

tilages. Its fibres aſcend almoſt perpendicularly below the arm-pit, to be inſerted into the ſpine of the humerus, which is, in this animal, very long.

The *latiſſimus dorſi* is only a fleſhy band, which ariſes from the ſpinous tubercles of the two laſt dorſal vertebræ. It has ſome connection with the *trapezius*, and uniting its tendon to that of the *teres major*, it is inſerted into the humerus in the hollow of the arm-pit.

The *ſupra* and *infra-ſpinati*, as well as the *ſubſcapularis*, preſent no variety worthy of notice.

The *deltoides* has no connection with the clavicle, unleſs, indeed, we conſider the ſecond portion of the *pectoralis major* as making a part of it: it extends over the whole external ſurface of the ſcapula, where it forms two portions: the inferior is more thin than the other. They reunite in a tendon, which paſſes over the joint, and is inſerted into the ſpine of the humerus.

There is no *teres minor*. The *teres major* has nothing remarkable. Its tendon unites with that of the latiſſimus dorſi.

The *coraco-brachialis* is wanting.

C. *In Birds.*

Birds have three pectoral muſcles, all attached to their very large ſternum, and acting upon the head of the humerus.

1. THE PECTORALIS MAXIMUS.

This weighs more than all the other muſcles of a bird's body together. It riſes from the os furciforme, the keel of the ſternum, and from the laſt ribs, and is inſerted into the very prominent linea aſpera of the humerus. It is by means of this muſcle that birds exert the ſudden and violent motions of the wings which are neceſſary for flight.

2. THE PECTORALIS MEDIUS *of Vicq. D'Azyr.*

This muſcle is ſituated in the angle formed by the body and keel of the ſternum, and in the interval between the fork and the clavicle. Its tendon paſſes through the hole formed by the union of the fork, clavicle, and ſcapula, as if it went over a pully, and is inſerted into the humerus, which it raiſes. By this pully nature has been enabled to place a levator at the lower part of the trunk, and thus bring the centre of gravity farther down, without which the bird would have been liable to overſet in the air.

3. THE PECTORALIS MINIMUS *of Vicq. D'Azyr,*

Ariſes from the lateral angle of the ſternum, and the baſe of the clavicle: it is inſerted under the head of the humerus, and brings this bone cloſe to the body.

There are, beſides, two little muſcles attached to the internal ſurface of the top of the clavicle.

They are inſerted into the great inferior tubercle of the head of the humerus, which they draw towards the trunk.

The *latiſſimus dorſi* of birds is formed of two parts. The anterior extends directly to its inſertion in the poſterior ſurface of the middle of the linea aſpera. The poſterior aſcends obliquely, to be inſerted under the head of the bone. Both are very thin.

Although the ſcapula has neither ſpine nor coracoid proceſs, we ſee muſcles analogous to the *ſupra* and *infra-ſpinati*, and the *teres major*.

The *deltoides* may be diſtinguiſhed as divided into a clavicular and ſcapular part. The latter ariſes only from about the neck of the ſcapula. Their inſertion is very low down in the humerus.

D. *In Reptiles.*

The pectoralis major of the *frog* is compoſed of two portions, placed one above the other. They produce two tendons, which are inſerted on each ſide of the humeral groove.

The *latiſſimus dorſi* ariſes from the inferior part of the back, where it is thin. It becomes thicker, and is attached to the broad part of the ſcapula, which it entirely covers. It is inſerted, by a ſtrong tendon, into the internal ſurface of the humerus, above one-third of its length from its ſuperior end.

In the *frog* there is neither the *ſupra* nor *infra-ſpinatus*.

The *ſubſcapularis*, or *coraco-brachialis*, (for the muſcle of which we now ſpeak ſupplies the place of both,) ariſes from the internal ſurface of the ſcapula, at its junction with the clavicle, and is inſerted into the interior part of the humerus, about one-third from the head.

The *deltoid* is formed of three portions. The firſt, which is the longeſt, and very ſlender, proceeds from the anterior part of the ſternum. The ſecond ariſes from the union of the clavicle with the ſcapula, at the internal ſurface, runs over the bone above the joint, then ſends a thin tendon to the firſt, in its paſſage, and is partly inſerted in the linea aſpera, and partly in the inferior portion of the humerus. The third is diſtinct: it riſes partly from both the ſcapula and clavicle, and is inſerted into the ſcapular extremity of the humerus.

The *teres major* and *teres minor* are wanting.

Beſides theſe muſcles, in which we diſcover an analogy to thoſe of mammiferous animals, there is one which ariſes from the ſecond tranſverſe branch of the ſternum, and is inſerted into the inner edge of the groove of the humerus by a broad tendon. It may be regarded as an *aſſiſtant to the pectoralis major*.

This conformation appears to prevail in the *ſalamander.*

If the *tortoiſe* has fewer muſcles proper to the ſhoulder than common, it has an extraordinary number inſerted into the humerus.

That which correſponds to the *pectoralis major* is compoſed of five portions.

Two are ſuperficial; one ariſes from the edge of the anterior part of the breaſt-plate, and proceeds to its inſertion in the leſſer tubercle of the humerus. The other is much more extenſive: it riſes from a great part of the internal ſurface of the breaſt-plate, and is alſo inſerted, by a flat tendon, into the leſſer tubercle of the humerus; but it is prolonged by a fan-like aponeuroſis, which extends over the inferior ſurface of the arm, and even the fore-arm.

One of the three deeper portions of the pectoralis major ariſes from the greater part of the ſecond bone of the ſhoulder, and is inſerted into the humerus, below its ſcapular articulation; another riſes from the expanſion of the interoſſeous ligament, which unites the ſecond bone of the ſhoulder to the third, and proceeds to join its tendon intimately with that of the preceding portion. Laſtly, the third, which is the moſt deep ſeated of all, ariſes from the ſuperior ſurface of the third bone of the ſhoulder, or that which is next the back-ſhell. Its tendon is conjoined with thoſe of the preceding.

The muſcle analogous to the *deltoides* is alſo compoſed of two portions; one ariſes from a ridge on the anterior part of the breaſt-plate; the other, which is its acceſſory, is placed more deeply, and united to its correſponding muſcle. They are inſerted, by one common tendon, into the leſſer tubercle of the humerus, which they draw towards the neck in the action of ſwimming.

There is another muſcle much deeper ſeated, which ſeems likewiſe an aſſiſtant to the *deltoides*. It riſes from the dorſal extremity, and all the internal edge of that bone of the ſhoulder which correſponds with the clavicle, and proceeds to be inſerted in the humerus below the leſſer tuberoſity.

On the internal ſurface of the humerus we find a muſcle riſing from the looſe extremity of the ſternal face of the third bone of the ſhoulder: it is inſerted in the humerus, about one-third from its lower end, by a thin tendon. It bears ſome relation to the *ſterno-radialis* of the *frog*, and performs the ſame office.

The *levator brachii* is a very thick muſcle, which ariſes from the third bone of the ſhoulder, the exterior edge of which it ſurrounds, and is inſerted into the proceſs of the humerus, reſembling the olecranon, which it pulls upward and outward.

A muſcle analogous to the *teres major*, ariſes from the neck of the third bone of the ſhoulder,

externally,

externally, and is inſerted into the humerus, between the two tuberoſities. It pulls the humerus backward.

Another muſcle, which ſeems a ſubſtitute for the *latiſſimus dorſi*, riſes from the interior part of the back-ſhell, to which it is attached obliquely, in the interval between the two firſt ribs. It is inſerted into the body of the humerus, behind the greater tubercle, by a flat tendon. It pulls the humerus toward the upper ſhell, when the animal ſtands upon all its four feet.

A muſcle, the uſe of which ſeems the ſame as that of the *levator brachii*, riſes from the whole internal ſurface of that bone of the ſhoulder which anſwers to the clavicle, and is inſerted into the whole length of the olecraniform proceſs, or great tuberoſity of the humerus. It is very fleſhy, and appears to be formed of two portions.

Finally, the muſcle analogous to the *ſcapulo-radialis*, or *biceps flexor cubiti*, ariſes from the anterior border of the humeral cavity, and is inſerted into the external and ſuperior ſurface of the humerus by a ſmall tendon, which reaches as far as the baſe of the radius. It extends the member, and brings it toward the head.

ARTICLE V.

Of the Bones of the Fore-Arm.

A. *In Man.*

IN Man the lower quarter of the humerus is gradually enlarged by two projecting lines ariſing from its two ſides, which diverge to form conſiderable tuberoſities, named condyles; the internal *(épitrochlée)* and the external *(épicondyle.)* The line on the internal ſide is the ſhorteſt, but its condyle projects moſt. This portion of the humerus is compreſſed behind and before; the anterior ſurface being convex, the poſterior flat. The inferior part between the condyles has two eminences which round off this end. The internal, which has the form of a pully, that is to ſay, of a circular channel ſlightly concave, is ſomewhat oblique, and its poſterior extremity larger, and turned more outward: above there is a large depreſſion to receive the olecranon.

The ſecond eminence is ſimply convex, and terminates poſteriorly, exactly below the inferior border of the bone, in ſuch a manner that its extent is only half of that of the pulley.

The *ulna*, which is larger towards the humerus, has a ſemicircular, or *ſigmoid* cavity, which receives the pulley of the humerus, by which it ſeems to have been moulded. Its poſterior edge is formed by the *olecranon*, and the anterior, which is the moſt prominent, by the *coronoid* proceſs.

The centre of motion is not in the axis of the humerus, but in that of the ulna, on account of the obliquity of the pulley; ſo that, in bending the arm, the lower extremity of the ulna is brought nearer the body.

This extremity is not ſo large as the other; it has a little head with a flat ſurface, round and prominent at the external ſide, and preſenting a ſtyloid proceſs at the internal.

The bone called *radius* has a round head, with a ſlightly concave articular ſurface, anſwering to the external proceſs, or leſſer head of the humerus, and capable of moving upon it as the ulna does upon the pulley. But this head is, beſides, capable of turning upon its own centre; this is facilitated by an articular ſurface of the external edge of the coronoid proceſs of the ulna, upon which the rounded edge of the head of the radius reſts. The inferior head, which is much larger, particularly at the external part, has a ſimilar ſurface, which reſts upon the outward edge of the inferior head of the ulna; and as the oppoſite edge of this inferior head of the radius is farther from the axis of motion, when the ſuperior head turns upon its centre, that edge deſcribes a circle round the little head of the ulna. In this motion the radius carries along with it the hand, which turns, at this time, upon the ſemilunar bone that reſts upon the little head of the ulna, like a door upon its hinge.

Hence ariſes the motion of *ſupination*, when the radius forms the outward edge of the fore-arm, and the palm of the hand is turned forward; and that of *pronation*, when the radius conſtitutes the internal edge of the fore-arm, and the palm of the hand is directed backward.

The ligaments which unite the bones of the fore-arm to the humerus, and to each other, are of various ſorts. There are, in the firſt place, the articular capſules of the correſponding ſurfaces: next, there are, on each ſide of the elbow, two ligaments: one proceeds from the internal condyle, and is inſerted into the coronoid proceſs; and the other, proceeding from the external, is inſerted into the capſular ligament of the radius. The two bones of the fore-arm are kept in their places by the interoſſeous ligament which paſſes from the ulnar edge of the radius to the radial edge of the ulna, and by a little oblique ligament which extends from the ſmall tubercle of the olecranon to the tuberoſity of the radius.

B. *In other Mammiferous Animals.*

In *monkies* the bones are arranged in the ſame manner as in man, except that in the *cynocephalus*, the *mandrills*, the *maggots*, the *guenons*, and ſome other ſpecies, the coronoid proceſs of the ulna is narrower, and the articular ſurface of the radius deeper. In the *ſapajous*, we generally remark a hole pierced in the internal ſalient line of the humerus. This bone is often perforated at the bottom of the cavity which receives the olecranon in the extended poſition. Their ulna is more compreſſed than the human.

The articulation of the fore-arm of the Pedimana, reſembles that of the *ſapajous*.

The *bat* and the *flying lemur* have no ulna, or, at moſt, only a rudiment of it, in the form of a ſtyle, ſituated under the radius. It remains diſtinct until it reaches within a quarter of the length of that bone from the lower end: conſequently thoſe animals have no motions of pronation and ſupination.

In the Carnivora, the olecranon is compreſſed, and extended farther back than in man. The pulley is not concave before, becauſe the articular ſurface of the radius, increaſing with the head of the bone, cuts off too much of the coronoid proceſs.

In the *dog* the head of the radius has a cavity for the little head of the humerus, and a ridge for the furrow that divides it from the anterior part of the pulley. On this account the rotation of the radius becomes obſcure. The poſterior border of the ſigmoid cavity enters into the hole which perforates the bottom of the poſterior cavity of the humerus. The external linea aſpera is more conſiderable, and the internal has a hole as in the *ſapajous.*

Notwithſtanding the ſhortneſs of the bones in the *ſeal,* their articulation is the ſame.

It is the ſame in ſome of the Rodentia, as the *paca, agouti, beaver,* (which laſt has the linea aſpera very prominent.) In others, as the *cavy,* the *hare,* and the *rat,* the coronoid proceſs of the ulna is entirely effaced, and we ſee nothing but the radius at the anterior part of the articulation. Its head forms a ginglymus, having a cavity for the little head of the humerus, and a ridge for the anterior part of the pulley.

The *marmotte,* the *porcupine,* &c. hold a middle place with reſpect to the ſmallneſs of their coronoid proceſs. Theſe animals have no hole in the linea aſpera of the humerus.

The *jerboa* has proceſſes like the *monkey.*

The Pachydermata, as the *rhinoceros,* the *hog,* and the *tapir,* have the radius entirely anterior, and the ulna behind. They move together by ginglymus in a ſingle pulley. The little head of the humerus is quite effaced inferiorly. The radius is at the internal, and the ulna at the external ſide of the fore-arm. Though theſe bones are diſtinct, there is not therefore any poſſible rotation.

In the *elephant,* the anterior part of the ſigmoid cavity, or coronoid proceſs, is divided into two ridges, with hollow ſurfaces turning upon the projecting edges of a ſingle pulley. Between them is the head of the radius; it is ſmall, and ſuſtained by the external ridge and middle channel of this pulley; for, as it is oblong, it cannot turn upon it. The inferior part of the radius is directed towards the internal ſide; the fore-arm is therefore always in a ſtate of pronation. The inferior head of the ulna is greater than that of the radius, and this is the only inſtance of the kind in mammalia.

In the remaining animals the ulna is only an immoveable appendage to the radius; and its ſigmoid cavity a continuation of the articular ſurface of the head of the radius, which performs only the motion of a ginglymus upon a ſingle pulley.

The ulna is anchyloſed with the radius almoſt its whole length in the Ruminantia. It is only diſtinguiſhed from it by a furrow, which has, however, a chink at top and bottom in the *giraffe*, *ſtags*, and ſome *gazelles*, and at the top only in *cows* and *ſheep*, but in no part in the *camel* and *dromedary*.

In the Solipeda we find a furrow with a ſlit at the top.

The Solipeda, the Ruminantia, and the Pachydermata, have the inferior head of the radius compreſſed behind and before, and the back of the carpus always turned forward.

From this variety of ſtructure it is obvious that the rotation of the hand becomes more difficult in proportion as the animal uſes it leſs for graſping, and employs the anterior extremity more excluſively in ſtanding and walking. Indeed theſe latter uſes require a conſtant pronation, and a firmneſs which is incompatible with ſupination.

For a ſimilar reaſon *bats* and *birds* are deprived of rotation. If their hand and radius could turn, the reſiſtance of the air would produce that effect at every effort of their wings; the plane of which would then become vertical, and flight be thereby rendered impoſſible.

Let us now conſider ſome animals whoſe ſtructure could not be brought within the general view we have taken.

In the *mole*, the poſition of the humerus is ſuch that its lower head is the moſt elevated; it happens therefore, that, when the fore-arm is in a middle ſtate between pronation and ſupination, the elbow is carried upward, the radius and thumb turned downward, and the palm outward. Each condyle has a proceſs in the form of a hook, pointing towards the ſhoulder. The olecranon is very long, and terminated by a tranſverſe plate. The ulna is a compreſſed longitudinal lamina. A very ſtrong ligament unites the palmar faſcia and the wriſt to the internal condyle. The edge of the head of the radius being prolonged under the little head of the humerus, it ſeems incapable of turning. The hole is found in the internal linea aſpera.

In the *ſeal* the ulna is compreſſed, inſtead of the great ſigmoid notch, there is one ſurface for the articulation of the humerus, and another oblique one for that of the radius. This has a large head, the internal edge of which runs in the pulley. The body is compreſſed, and very broad downward. There is a hole in the internal linea aſpera, and the olecranon is compreſſed, high and ſhort.

In the *lamantin* the ſuperior and inferior heads of the two bones are anchyloſed together.

In the *dolphin* theſe two bones are compreſſed and flat, and ſeem united by ſynchondroſis with the humerus and carpus.

They are ſimilar in the *cachalot*, and without doubt in all other Cetacea.

C. *In Birds.*

The lower end of the humerus is nearly alike in birds and mankind. There are in the ſame manner between the condyles, two articular proceſſes, of which the external is not a portion of a ſphere, but rather a portion of a pulley; ſo that the radius may eaſily move upon it, but not turn upon its own centre. That which anſwers to the pulley is entirely convex and round. The ulna is capable of extenſion and flexion upon it, by means of a cavity which it poſſeſſes. It bears alſo another leſſer cavity upon the external proceſs. The olecranon is very ſhort.

The radius, which is ſlenderer than the ulna, remains parallel to it. Its lower head is leſs than that of the ulna, and terminates in a triangular ſurface.

The inferior head of the ulna ends in the ſegment of a pulley, on which the ſecond bone of the carpus performs the motions neceſſary for the adduction and abduction of the hand.

The *manchot* has this part ſomewhat differently conſtructed. The bones of the wing in this bird are extended in the ſame plane, like thoſe of fins. The radius and ulna are quite flat, and articulated by arthrodia to two tubercles, placed one above, and the other at the bottom of the anterior edge of the humerus; ſo that the wing of the manchot is to that of other birds what the thoracic member of the Cetacea is to that of the other mammalia.

D. *In Reptiles.*

The humerus of the *crocodile* terminates in two round tubercles. The hollow head of the radius turns upon the external one. Between them the round head of the ulna is ſituated, but it has neither olecranon nor ſigmoid cavity. In the upper part it is the largeſt of the two bones, but the ſmalleſt below.

There is nearly the ſame conformation in the *cameleon*, but the bones are more elongated, and the inferior head of the radius is leſs than that of the ulna.

In the *frog* the ſingle bone of the fore-arm is articulated by a concave head, with a large round tuberoſity on the baſe of the humerus, between its two condyles. On each ſide, where the lower part of this bone becomes larger, we obſerve a furrow, which is the only veſtige of a diſtinction into two bones.

The two bones of the fore-arm of *ſalamanders* are ſituated one above the other. The ulna, which is the loweſt, and ſomewhat longeſt of the two, has no olecranon; but there is a ſort of rotula in the tendon of the extenſor muſcles. The ulnar extremity of the humerus is much enlarged. The articular ſurface which terminates it is convex, and permits the radius and ulna to turn together in every direction.

The two bones of the fore-arm in the *turtle* are always in a forced ſtate of pronation. The radius, which is much longer than the ulna, and fixed to it by a cartilaginous ſubſtance, is the loweſt, and extends even under the carpus.

Theſe two bones much reſemble each other in the humeral extremity, being formed by a ſingle concave ſurface received upon a correſpondent pulley of the humerus. Their articulation is ſuch that it allows them to move together laterally, and a little upward and downward in the action of ſwimming.

ARTICLE VI.

Of the Muſcles of the Fore-Arm.

1. OF THE FLEXORS.

A. *In Man.*

THE ulna, in the human ſpecies, has but one kind of motion upon the humerus, flexion and extenſion.

The flexor muſcles are:

1. THE BICEPS FLEXOR CUBITI, *or* SCAPULO-RADIALIS.

This ariſes by two tendons, one internal, and common to it and the coraco-brachialis, and attached to the coracoid proceſs; it is very ſhort: The other is external, and much longer; it comes from the ſuperior edge of the glenoid cavity of the ſcapula, and runs over the head of the humerus, into the channel between the two tubercles. The muſcle is inſerted inferiorly into a tubercle on the ulnar ſide of the radius, ſomewhat below its neck.

2. THE BRACHIALIS INTERNUS, *or* HUMERO-ULNARIS,

Is attached to about one third of the lower and anterior part of the humerus, and is inſerted by a tendon into a tubercle, before the coronoid proceſs of the ulna.

B. *In other Mammiferous Animals.*

Theſe two muſcles are ſimilar in *monkies*, except that the *brachialis internus* aſcends almoſt to the neck of the humerus.

In the Carnivora the *ſcapulo-radialis* cannot be called biceps, as it has only one head, which ariſes from the edge of the glenoid cavity of the ſcapula. In the *bear*, however, the *coracoid* head of this muſcle is repreſented by a little ſlip ſent off to it by the coraco-brachialis.

The *brachialis internus* ariſes from the poſterior and exterior part of the humerus, and is ſituated at the external part of the ſcapulo-radialis. Its inſertion is the ſame as in man.

The ſame conformation obtains in the Rodentia, Ruminantia, and Solipeda. In the laſt family, however, the hippotomiſts have given theſe two muſcles the names of *flexor cubiti longus et brevis*.

C. *In Birds.*

In Birds the *flexor longus*, which does not exactly correſpond to the *biceps*, ariſes by a long tendon from the ſcapula, and by a very ſhort one from the humerus, below its inferior tubercle. It is inſerted into the ulna. The *flexor brevis* is extremely ſmall; it ariſes from the internal linea aſpera, and paſſes, after expanding a little, to its inſertion in the internal ſurface of the head of the ulna.

There is, beſides, the FLEXOR PROFUNDUS of *Vicq D'Azyr.* It ariſes from the external condyle, under the ſupinator brevis, and extending over the ſuperior third of the ulna, is inſerted into the part next the radius.

2. OF THE EXTENSORS.

A. *In Man.*

The human fore-arm is extended by the TRICEPS EXTENSOR CUBITI, or OLECRANO-SCAPULARIS, compoſed of three parts uniting in a common tendon inſerted into the olecranon. They are diſtinguiſhed by different names. The firſt, which ariſes from the edge of the ſcapula, below the glenoid cavity, is called the *extenſor longus.* The ſecond, which ariſes from the poſterior ſurface of the humerus, below the head, is named the *extenſor brevis.* Finally, the third, which ariſes from the external lateral ſurface of that bone, is denominated the *brachialis externus.*

There is a little bundle of fleſhy fibres which come from the external condyle of the humerus, and are inſerted into the upper part of the ulna: it aſſiſts the preceding muſcles, and is called ANCONEUS, or EPICONDYLO-ULNARIS.

B. *In other Mammiferous Animals.*

In the *monkey* there is a fourth portion, which ariſes from the common tendon of the *latiſſimus dorſi* and *teres major.* Beſides, the ſuperior tendon of the *extenſor longus* reaches almoſt over the whole inferior edge, or coſta of the ſcapula.

This fourth part is alſo found in the Carnivora; but in theſe animals the part anſwering to the *extenſor brevis* in man, is divided into ſeveral portions, which ariſe from different points of the humerus. This portion is divided into four in the dog, in which the *brachialis externus* is extremely large, and the *extenſor longus* occupies the whole poſterior edge of the ſcapula.—In the *cat*, which has the *extenſor longus* and *brachialis externus*, like thoſe of mankind, it is divided into two.

Among the Rodentia, the *rabbit* has three portions like thoſe of man. There are, beſides, that which ariſes from the common tendon of the latiſſimus dorſi, and teres major, and a faſciculus, which, having the ſame origin as the *extenſor longus*, mixes its fibres very high up with the *brachialis internus.*

The *horſe* has three portions like man; namely, the *extenſor longus*, called, by Bourgelat, EXTENSOR MAGNUS, which is triangular, and very thick; the *brachialis externus*, or EXTENSOR BREVIS; and the extenſor *brevis*, or EXTENSOR

Medius of Bourgelat. There is, beſides, the fourth portion, which ariſes from the common tendon of the latiſſimus dorſi and teres major, but which appears very evidently to adhere to the edge of the ſcapula.

The great ſtrength and complication of the extenſors of the fore-arm in quadrupeds, have their utility in progreſſive motion. They perform, in theſe animals, the ſame function in the anterior extremity, that the extenſors of the heel do in the poſterir extremity, and are exerted to carry the body of the animal forward, when the foremoſt foot is planted on the ground to ſupport it. The Cetacea, in which the two bones of the fore-arm are not moveable upon the humerus, want theſe muſcles.

The little muſcle called *anconeus* in man, is found in all the above-named animals.

The *bat* has only one flexor and one extenſor muſcle to the fore-arm. The ſuperior part of the *flexor* is formed of two fleſhy bellies, one of which ariſes from the upper part of the humeral cavity of the ſcapula, and the other from the coracoid proceſs. Their common tendon begins about one third of the length of the humerus from its head, and is inſerted into the anterior ſurface of the humeral extremity of the ſingle bone of the fore-arm.

The *extenſor* is likewiſe compoſed ſuperiorly of two bellies, the tendon of one of which is attached behind, and to the large tubercle of the humerus, and that of the other to the top of the humeral angle of the ſcapula. Their fibres join about one third from the top of the humerus; they ſoon after form a tendon, which paſſes behind the joint, and is inſerted into the olecranon. It contains, in its ſubſtance, a kind of rotula.

C. *In Birds.*

Birds have the *extenſor cubiti* compoſed of two portions; one proceeding from the ſcapula, and called, by Vicq D'Azyr, EXTENSOR LONGUS; the other from the humerus, forming the EXTENSOR BREVIS of that Anatomiſt. There is alſo an ANCONEUS MINOR.

3. OF THE SUPINATORS.

The bones of the fore-arm move one over the other, and give to the hand that motion by which the palm is turned upward or downward. Theſe motions are termed *ſupination* and *pronation.*

A. *In Man.*

Supination in man is performed by two muſcles, which are called the long and ſhort ſupinators.

1. THE SUPINATOR RADII BREVIS, *or* EPICONDYLO-RADIALIS,

Ariſes from the external condyle of the humerus, and the adjacent part of the capſular ligament. It proceeds obliquely, and embraces the ſuperior part of the radius, which it turns upon its axis, from within, outwardly.

2. THE SUPINATOR RADII LONGUS, *or* HUMERO-SUPER-RADIALIS,

Ariſes, likewiſe, from the external condyle, but above the preceding muſcle. It produces a thin tendon, which is inſerted into the lower head of the radius, which it moves round that of eht ulna, from within, outwards.

B. *In other Mammiferous Animals.*

The *monkey* has preciſely the ſame muſcles.

The *bat* has no muſcles intended for ſupination, as that motion would deprive it of the faculty of flying.

The *cat* and *dog* have the *ſupinator brevis*; but the *longus* is wanting.

The *tapir* has neither. Theſe muſcles are likewiſe wanting in the Pachydermata, the Ruminantia, and Solipeda.

C. *In Birds.*

Theſe animals have no ſupinator muſcles.

4. OF THE PRONATORS.

A. *In Man,*

Pronation is performed by two muſcles.

1. THE PRONATOR RADII TERES, *or* EPITROCHLO RADIALIS,

Is ſituated oppoſite the ſupinator brevis. It ariſes from the internal condyle of the humerus, and is inſerted into the interior and ſuperior part of the radius.

2. THE PRONATOR RADII QUADRATUS, *or* CUBITO-RADIALIS,

Is extended directly between the inferior or carpal quarter of the ulna and radius, upon their internal ſurface.

B. *In other Mammiferous Animals.*

The *monkey* and the Carnivora have theſe two muſcles diſpoſed in the ſame manner.

The *bat*, which has only one bone of the fore-arm, or only a rudiment of the ulna, wants the *pronator* muſcles.

The *rabbit* has only the *pronator teres*, the action of which is very much confined on account of the immobility of the radius.

The Ruminantia and Solipeda have no *pronators*.

In the Cetacea, which have not the fore-arm moveable upon the humerus, there are no muſcles calculated for ſupination or pronation. Some aponeurotic rudiments of muſcles are merely expanded over the whole ſurface of the bones, and ſtrengthen their articulations.

C. *In Birds.*

Birds have two muſcles which occupy the place of the *pronator teres*, and have ſimilar inſertions; they ſeem to act as flexors.

There is alſo a ſmall one inſtead of the *ſupinator brevis*, which ſeems intended to bend the fore-arm, ſo that their uſes are totally changed.

5. MUSCLES OF THE CUBITUS IN REPTILES.

The *frog* has, properly ſpeaking, no *biceps*: Its place is ſupplied by another and much ſtronger muſcle ſituated on the breaſt under the pectoralis major, with which it has the ſame inſertions. At the articulation of the humerus it ſends out a ſtrong tendon, which paſſes along the groove of the humerus, and through a tendinous ring formed by the two parts of the pectoralis major under the deltoides. It is inſerted into the humeral extremity of the radius, and may be named STERNO-RADIALIS.

There is no *brachialis internus*.

The *triceps* is compoſed of three parts, nearly as in man, but they are proportionably larger.

There

There is but one *ſupinator*, which ariſes from the external condyle, and is inſerted into the carpus.

There is alſo but one *pronator*, which riſes from the internal condyle, and is inſerted into the carpus.

In the *turtle* theſe muſcles are almoſt entirely aponeurotic, and produce but very little motion, the place of the member being ſupplied by a fin as in the Cetacea. In general the muſcles of the humerus produce the motions of the fore-arm.

ARTICLE VII.

Of the Bones of the Hand.

THE hand is compoſed of a great number of little bones, which render the ſmalleſt parts extremely moveable. Some are ſituated in the ſuperior part, or that adjacent to the fore-arm. Theſe are called the bones of the carpus or wriſt.

1. OF THE BONES OF THE CARPUS.

A. *In Man*,

They are little, and preſent ſeveral ſurfaces which correſpond to each other at the points of their articulation. They are diſpoſed in two ranges, each compoſed of four bones; the firſt range is articulated to the depreſſions at the extremities of the radius and ulna. The radius oppoſes to them a large ſurface, truncated towards the ulna, and ſomewhat hollow, bearing a point on the internal ſide. The articular ſurface of the ulna is conſiderably ſmaller.

Two of the little bones of the firſt range are joined to the radius; one of them is called the *ſcaphoides*, and the other the *lunare*. A third articulates with the ulna, and is called the *cuneiforme*. This laſt bears upon its inſide, near its ulnar border, a little round bone which projects towards the palm of the hand, and is called *piſiforme*, or *inordinatum*, according as it is conſidered with reſpect to its form or its ſituation.

Theſe three bones of the firſt range, which are articulated to the fore-arm, are retained in their ſituation by a very looſe capſular ligament, which contains within it an interarticular cartilage of a triangular form. Ligamentous fibres alſo extend to the cuneiform bone. Theſe ariſe from the articular depreſſion of the ulna; and are called the *external tranſverſe ligament*. There are two other ligaments nearly ſimilar, on the inſide, which come from the ſtyloid proceſs of the radius; the one is inſerted into the ſcaphoides, and the other into the tubercle of the ſemilunar bone.

In the ſecond range of the carpal bones two are articulated to the ſcaphoides. Theſe are the *trapezium*, which ſupports the firſt phalanx of the thumb, and has a ſharp eminence within the palm of the hand; and the *trapezoides*, to which the metacarpal bone of the index is articulated. The next is the *os magnum*, which is articulated both to the ſcaphoides and lunare, and ſuſtains the metacarpal bone of the middle finger, and a ſmall part of that of the ring finger; the laſt is the *unciforme* or *hook-bone*, which is articulated to the os cuneiforme; it ſupports both the ring finger and the little finger, and produces towards the palm of the hand a large proceſs in form of a hook.

The carpus moves upon the fore-arm both forward, backward and ſideways; but though the motions of its parts, with reſpect to each other, and the metacarpus, are quite complete, they are ſcarcely apparent. This mechaniſm produces great delicacy of movement in the bones of the carpus; yet ſuch is the effect of their union, that the whole hand may be moved by a ſingle muſcle inſerted into one of the bones that compoſe it.

A capſular ligament unites the firſt range of the bones of the carpus to the ſecond, and another joins theſe to the articular baſes of the metacarpal bones. The other ligaments of the carpus are fitted to unite together, in different modes, all theſe bones. Their figure and direction are therefore very various.

B. *In other Mammiferous Animals.*

The carpus of the *monkey* has one bone more than that of man. It is ſituated between the baſes of the pyramidal and great bone. It ſeems to be produced by a diviſion of the trapezoid. The os piſiforme is more prominent, becauſe it is longer, and ſerves as a heel to the hand of this animal.

There are, beſides, almoſt always certain oſſified points in the tendons of the muſcles, which are commonly conſidered as ſupernumerary bones. There are two, for inſtance, in the *gibbon* and the *maggot*; one in the tendon of the ulnaris externus, upon the joint of the piſiform and the cuneiform bones; the other without the range on the edge of the ſcaphoides and trapezoides. In the *ſapajous* the former is wanting.

In the *rouſſette*, or *ternate bat*, there are two bones in the firſt range, namely, a large one belonging to the radius, and a very ſmall one anſwering to the ulna: the four ordinary bones are found in the ſecond range: the third bone, which correſponds with the ſecond finger, has a very large ſurface towards the inner part of the hand.

In the Carnivora in general, but eſpecially in the *dogs*, *cats*, *hedge-hogs*, *ſhrews*, *bears*, and *ſeals*, the ſcaphoid and lunar bones only form a large ſingle bone by their junction. In the *cats* there is at the internal edge of the carpus a little ſupernumerary bone reſembling the piſiforme in man, but ſituated at the oppoſite ſide. The piſiforme in the Carnivora is very long, and ſerves as a ſort of heel to the anterior feet. This laſt peculiarity does not occur in the *ſeals*.

The bone analogous to the *os magnum* in man, is very ſmall towards the back of the carpus. Theſe that have only a rudiment of the thumb, as the *hyæna*, have the trapezium very ſmall.

The ſame rule applies to the *glutton*; but that animal has alſo a ſtyloid appendix to the carpus, ſituated below the os ſcaphoides.

In the *mole* there are the ſame nine bones as in the *monkey*, and, another ſimilar to the blade of a ſcythe, with which the radial border of the hand is furniſhed throughout its whole length: This bone cauſes the great ſize and ſhovel-like figure of that member, which ſuits the habits of the animal. The *mole* has, beſides, this ſingularity—its toes are very ſhort, covered by the ſkin and the great-toe nails only viſible on the outſide.

With reſpect to the Rodentia, the *hare* has bones like the *monkey*; but the *beaver*, the *marmot*, the *ſquirrel*, and *rats*, have, like the Carnivora, a ſingle bone for the ſcaphoides and lunare. The ſupernumerary bone is as large as the common piſiforme, and often larger. It ſometimes ſupports a ſecond ſupernumerary bone, as in the *jerboa* and *marmot*; ſo that on each ſide of the range there is an irregular bone of equal magnitude.

The pyramidale in the Rodentia is, in general, divided in two, as in the *monkey*. The *porcupine* differs only in this, that the pyramidal bone is not divided, and that there is a ſupernumerary bone between the piſiforme and the metacarpal bone of the fifth toe. It is attached to the os unciforme.

In the Cavys, the ſcaphoides and the lunare are united without any ſupernumerary bone. There is, however, a ſmall ſupernumerary bone in the *guinea-pig*. The os pyramidale is not divided in the *paca* and *agouti*, though in the *cavy*, properly ſo called, as well as in the guinea pig, it is divided. In both theſe animals the only veſtige of the thumb is a ſmall bone ſituated upon the trapezium, with which it is articulated. This rudiment of the thumb conſiſts of three ſmall bones in the *marmotte* and the *agouti*.

The *two-toed ant-eater* has four bones in the firſt range of the carpus; two radial, one ulnar, and one long piſiforme without the range. There are only two bones in the ſecond range; they correſpond with the ſecond and third fingers. On the radial edge of the firſt there is the veſtige of a thumb formed of a ſingle piece. On the ulnar extremity of the other there is a half-articulated veſtige of the ring finger: there is alſo a much ſmaller bone in a ſingle piece, which is the rudiment of the little finger.

The *three-toed ſloth* has only five bones in the carpus; three in the firſt range, the piſiforme being wanting; and only two in the ſecond.

The carpus of the *pangolins* appears to have ſeven bones, like that of the Carnivora. The *nine banded armadillo* has eight, and a rudiment of the little finger.

The carpus of the *elephant*, like that of man, has eight bones, but they have a different configuration. The piſiforme is elongated: the others are cuneiform.

Among the Pachydermata the *hog* has, in the firſt range, four bones ſimilar to thoſe of man; but in the ſecond range the trapezium is very ſmall, and no veſtige of the thumb appears upon it: it is the ſame with reſpect to the *tapir*, whoſe fore-foot differs from that of the hog only in the lateral toes being larger. The ſtructure of that foot is exactly ſimilar in the *hippopotamus*.

The *Rhinoceros* has only three toes; but as the pyramidale, the os magnum, and the unciforme, belong each to one of the three, the trapezium only is wanting. There is, however, a ſupernumerary bone on the edge of the ſcaphoides, and one on that of the unciforme, as in the *porcupine*.

The Ruminantia have the four bones that uſually belong to the firſt range; but they are more narrow in proportion to their length. Moſt of them have two in the ſecond range. The *camel*, however, has three. The Solipeda have four in the firſt range, and three in the ſecond.

The bones of the carpus in the *dolphins* and other Cetacea, are very much flattened, almoſt all of a hexagonal figure, and form by their union a compact ſurface reſembling a pavement. There are three bones in the firſt range, and only two in the ſecond.

2. OF THE BONES OF THE METACARPUS.

Each of the fingers is ſupported at its baſe by a long bone which is united with ſimilar bones belonging to the other fingers, in ſuch a manner as to form with them only very obſcure motions. Theſe are called the *metacarpal bones.*

A. *In Man.*

The thumb, which has only two phalanges, is the only finger the metacarpal bone of which is capable of a conſiderable ſeparation and approximation with reſpect to the others. The other metacarpal bones cannot be ſeparated beyond the extent at which they are fixed by the ligaments between them, called the *inter-metacarpal ligaments.* Theſe bones are beſides faſtened to thoſe of the ſecond range of the carpus, by a number of articular ligaments, which are divided into the *palmar,* the *ſub-palmar,* and the *lateral.*

At the digital extremity of each metacarpal bone there is a ſmooth tubercle, which receives the firſt phalanx of each finger. The carpal extremity exhibits ſeveral ſurfaces, of which the principal one correſponds with the bones of the carpus, and the other ſmaller and lateral ones with the neareſt metacarpal bones. Theſe bones are almoſt ſtraight in man.

B. *In other Mammiferous Animals.*

The Mammalia in general have as many bones in the metacarpus as they have toes: In the Ruminants and Solipeda, however, the two metacarpal bones are, at a very early period, united into one bone, called the *cannon bone.*

The length of the metacarpal bones varies in proportion as the animal walks more or leſs on the extremities of the toes, or as it uſes the anterior feet, like a hand, to ſeize objects.

The whole of the metacarpus is elevated, and forms what is vulgarly called the fore-foot, in *dogs*, *horſes*, *ſheep*, &c.

In the *three-toed ſloth*, the three metacarpal bones are united into one at their baſe, and there is joined to them the rudiment of a fourth bone; at leaſt this is the caſe with the adult individual preſerved in the Muſeum.

The bones of the metacarpus are likewiſe intimately joined together, and are exceedingly flat in the Cetacea.

III. *The*

3. OF THE BONES OF THE FINGERS.

The fingers are the free and moveable parts which terminate the hand.

A. *In Man.*

They are five in number. Each of them, the thumb excepted, is compoſed of three phalanges, the firſt of which, or that which articulates with the metacarpal bones, is the longeſt. The ſmalleſt is that which terminates the finger, and which bears the nail *(unguinal.)* It is eaſy to diſtinguiſh the phalanges from one another. The baſe of the firſt has a ſmooth oblong articular cavity, which correſponds with the digital extremity of the metacarpal bones. In the ſecond the articular ſurface of the baſe is compoſed of two ſmall foſſæ, ſeparated from each other by a little projecting eminence. Finally, the laſt phalanx is terminated by a ſcabrous and inarticular ſurface.

Theſe three bones gradually diminiſh in thickneſs, but they are nearly ſtraight throughout their whole length. They have an articular capſule and lateral ligaments at each of their extremities. There are, beſides, a number of ligamentous fibres and vaginæ, by which the tendons of the muſcles of the hands, inſerted in thoſe bones, are preſerved in their proper poſition.

B. *In other Mammiferous Animals.*

If we include the rudiments, which are ſometimes very imperfect, and frequently concealed under the ſkin, there are never leſs than three, nor more than five toes, on the anterior feet of the Mammalia.

The Solipeda have two imperfect and one perfect, in all three.

The *rhinoceros* has three perfect.

The Ruminantia, two imperfect and two perfect, in all four.

The *tapir* and *hippopotamus* have four perfect.

All animals with claws have five, reckoning the perfect and imperfect.

Every perfect finger has three phalanges, except the firſt, on the ſide of the radius, or the thumb, which never has more than two. Theſe phalanges are capable of complete flexion, but none of them can be extended beyond a right line, except the firſt, and, in ſome ſpecies, the laſt.

The Quadrumana, like man, have the thumb ſeparate, and capable of being oppoſed to the other fingers. In this conſiſts the real characteriſtic of the hand; but the human thumb is always longer, in proportion to the other fingers, than that of the Quadrumana, whoſe hand, in this reſpect, does not poſſeſs the perfection of ours. It is even obliterated, and concealed under the ſkin, in the *coaita (Simia paniſcus* Linnæi.)

The laſt phalanx, or that on which the nail is placed, is leſs flat and more pointed than that of man. The bones of the metacarpus and the firſt phalanges, are alſo much more curvated towards the palm of the hand.

The *rouſſets* and *common bats* have the phalanges exceedingly long, particularly the laſt, which are very much pointed, and have no nails. The thumb, however, is not ſubject to thoſe deviations. It is ſhort, and has a nail.

In the Carnivora, the thumb remains parallel to the other toes; by this conformation, theſe animals are deprived of the faculty of pinching, or ſeizing ſmall objects. In the *ſeal* the great toe is longer than the others; it is almoſt of an equal length in the *bears*, *badgers*, *racoons*, and *coatis*. The *opoſſums* have it a very little ſhorter. It is obviouſly ſhorter in *weaſels*, *civets*, *cats*, and *dogs*.

It is obliterated and reduced to a ſingle phalanx in the *hyæna*.

The form of the laſt and ſecond phalanges is very remarkable in the family of *cats*, the individuals of which have the power of raiſing their claws, leſt they ſhould be blunted by remaining on the ground while they walk.

The ſecond phalanx is triangular. Two of its ſurfaces are lateral, and one inferior. The internal lateral ſurface, or that which is next the thumb, exhibits a kind of twiſt, in conſequence of which the middle part is rendered oblique, and as it were hollowed.

The third phalanx, or that to which the claw is attached, is ſtill more ſingular in its form, its articulations and its motions.

The figure of this phalanx is that of a hook, conſiſting of two parts; one part which is directed forward, and is curvated, cutting and pointed, receives the claw, the form of which is nearly the ſame. The baſe of this firſt portion forms a kind of oſſeous hood, into which the baſe of the nail is received as in a ſheath, but in ſuch a manner that it cannot be puſhed backward. The ſecond part of the hook is ſituated poſteriorly. It riſes almoſt vertically, and is only articulated at its moſt inferior part. It is prolonged beneath the articulation in two appendices, to which are attached the two muſcles that project the claw, and bend the phalanx—motions which take place at the ſame time. The articulation of this bone is indeed ſo diſpoſed, that, upon its extenſion, which takes place greatly beyond a right line, it experiences an inverſion by being turned upwardly and poſteriorly on the ſecond phalanx, towards the internal or radial ſide. In this ſituation the lateral depreſſion of the ſecond phalanx ſerves to receive the third, and the point of the claw far from touching the ground is directed upward.

This inverted poſition is the ſtate of inaction. The phalanx is preſerved in it by the articular capſule, and two lateral ligaments which proceed from the ſecond phalanx.

A perfect thumb is found in the family of the Rodentia. It is however ſhort in the *hares*, *beavers*, *jerboas*. *Squirrels*, *rats*, *porcupines*, the *paca*, the *agouti*, &c. have a diminiſhed thumb, with two phalanges. Finally, the *cavy*, the *guinea-pig*, the *marmot*, &c. have a thumb nearly obliterated, of which only a ſingle rudiment remains. In general the laſt phalanges are very narrow, long, almoſt ſtraight, and pointed. The great *cavy* forms however one exception. In it the laſt phalanges are triangular, and enveloped in a real hoof.

The Edentata exhibit many variations with reſpect to the number of the toes in the anterior feet. The *tamanoir* or *great ant-eater*, and the *four-toed ant-eater*, have the thumb obliterated. The thumb and the little toe are both obliterated in the *three-toed ſloth* or *ai*, in which a number of other very remarkable particularities are obſervable. Its three perfect toes are often intimately united together at their baſes with the metacarpal bones; this very much limits their motion: beſides, each of the toes conſiſts only of two phalanges, the articulations of which, both with the bones of the metacarpus, and with each other, take place by pulleys that have very narrow and deep grooves. This conſtruction renders lateral motion abſolutely impoſſible. Finally, the laſt phalanx is much longer than the firſt. It is covered by the nail throughout almoſt the whole of its length, and has at its baſe a kind of oſſeous ſheath or hood, which is much deeper on the inferior than on the ſuperior part.

The thumb, the index, and the little finger, are obliterated in the *two-toed ant-eater*, and in the *unaü*, or *two-toed ſloth*.

The *elephant* has five perfect toes; but the whole five are almoſt entirely concealed under the thick ſkin which envelopes the foot.

In the *hoofed* animals, that have four toes, as the *hog*, the *tapir*, and the *hippopotamus*, we alſo obſerve a ſmall bone which is the rudiment of the thumb. The two lateral toes of the *hog* are ſhort, and do not touch the ground: they are however perfect with reſpect to the number of the bones of which they are compoſed. In thoſe animals the laſt phalanx is ſet into the interior of the horn which terminates the foot.

The Ruminantia, as we have obſerved, have only one metacarpal bone, which ſupports the two toes that form what is commonly called the cloven-foot. Several ſpecies have alſo, at the roots of the two perfect toes, two little bones, which are frequently covered with ſmall nails, and which repreſent two other toes. The laſt phalanx of each toe is always of a triangular figure. Two of the ſurfaces are lateral; the internal being plane, and the external convex.

In the *horſe*, and the other Solipeda, the only veſtige of the lateral toes are two ſharp-pointed bones growing on each ſide of the cannon-bone. The three phalanges of the only toe that exiſts, are called the *paſtern*, the *coronet*, and the *coffin bone*. This laſt phalanx has the form of a hoof. It is rounded, flat inferiorly, and convex ſuperiorly.

The Cetacea have all the phalanges flattened, united in the form of a fin, and frequently cartilaginous. Such, in particular, is the caſe with reſpect to the *porpoiſe*, the *dolphin*, and the *cachalot*.

4. OF THE BONES OF THE HAND IN BIRDS.

There is only one row of bones in the carpus of birds; the ſecond appears to be anchyloſed with the part which repreſents the metacarpus.

This row of the carpus conſiſts only of two bones. The one, which is radial, and of a rhomboid form, prevents the metacarpus from being too much extended. The other is ulnar, in the form of a wedge, and in its internal angle the ulnar ſide of the end of the metacarpal bone is implanted. It has frequently a tubercle, which correſponds with the piſiforme of Mammalia.

The metacarpal bone is formed of two branches, which are united, by oſſification, at their extremities.

On the radial ſide of its baſe it has a particular proceſs, or ſmall ſeparate bone, which bears a ſtyloid bone repreſenting the thumb. On the

extremity

extremity of the metacarpal bone there is a long finger, conſiſting of two phalanges. The firſt is almoſt rectangular, and is compreſſed like a knife. The ſecond is ſtyliform. There is alſo a ſhort finger of only one phalanx, which has the form of a ſtillet. The thumb ſuſtains the falſe or baſtard quills; the primary or chief are placed upon the long finger and metacarpal bone. The little finger bears none; it is concealed under the ſkin.

All the bones of the hand or wing of the *manchots* are compreſſed, and appear like thin plates.

5. OF THE BONES OF THE HAND IN REPTILES.

The *frog*, the *toad*, and the *ſalamander*, have three ranges in the carpus. The firſt conſiſts of two bones, one radial and one ulnar. The ſecond conſiſts of three bones, the largeſt of which bears the rudiment of a thumb with two joints. The third range has likewiſe three bones. The ſecond finger proceeds from the firſt of theſe bones. The fourth finger is articulated with the ſecond bone. The middle finger articulates with both bones. The little finger joins the third bone. The firſt range touches the third inferiorly, becauſe the ſecond is cuneiform. There is no bone without the range.

In the *mud tortoiſe* the firſt range is a ſingle bone, which ſeparates the radius from the ulna.

The ſecond range conſiſts of two bones, and a ſmall one out of the row, ſituated on the ulnar edge. The third range conſiſts of five bones, one for each bone of the metacarpus.

The *ſea tortoiſe* has three bones in the firſt range. The ulnar bone being longeſt, the two anterior bones do not advance much farther. The third range conſiſts only of three bones for thoſe of the metacarpus, and one ſmall bone out of the row, ſituated upon the radial ſide.

In the *crocodile* the firſt range conſiſts of two long parallel bones. It has beſide two little external bones without the range on the radial ſide.

The number of the phalanges varies in theſe animals.

The *crocodile* has the hand rounded: it has two phalanges to the thumb, three to the ſecond finger, four to the middle and fourth finger, and only three to the little finger.

The *cameleon* has three fingers on one ſide, and two on the other, which form, with the three oppoſite to them, a kind of forceps. The number of the phalanges is the ſame as in the crocodile, with the exception of the little finger, which has four.

In the *ſalamander* the little finger is obliterated, and the thumb has only two phalanges.

The *frog* has only one phalanx to the thumb. The two following fingers have only two phalanges. The other two fingers have three.

The hand of the *ſea-tortoiſe* is long, and compreſſed in the form of a fin; it terminates in a point. There are two phalanges to the thumb, three to the three ſucceeding toes, and two only to the laſt.

A ſimilar conformation is obſervable in the *mud-tortoiſe*; with this exception, that its hand is rounder.

Article VIII.

Of the Muſcles of the Hand.

I. Muscles of the Carpus and Metacarpus.

A. *In Man.*

The muſcles which act on the carpus and metacarpus are named *radial* and *ulnar*, according to the ſide of the fore-arm along which they are extended; and *internal* and *external*, according to the condyle of the humerus to which they are attached.

The os piſiforme is the only bone of the carpus into which one of thoſe muſcles are inſerted; that muſcle is

THE ULNARIS INTERNUS, *or* EPITROCHLO-CARPALIS.

It ariſes from the internal condyle of the humerus, and the poſterior ſurface of the ulna, and extends along the ulnar ſide of the fore-arm.

THE ULNARIS EXTERNUS, *or* CUBITO-SUPER-METACARPALIS.

This muſcle riſes from the other condyle of the os humeri, deſcends on the outſide of the preceding muſcle, and is inſerted in the external baſe of the metacarpal bone of the little finger.

THE RADIALIS INTERNUS, *or* EPITROCHLO-METACARPALIS,

Proceeds from the internal condyle of the humerus, and ſends off a tendon, which paſſes under the hook of the os unciforme bone, and is inſerted into the baſe of the metacarpal bone of the index.

THE RADIALES EXTERNI.

Theſe muſcles are two in number. They ariſe from the external condyle of the humerus, and proceed, the one upon the other, to the external ſide of the radius, and thence deſcend to their points of inſertion. The firſt (HUMERO-SUPER-METACARPALIS,) is attached to the external baſe of the metacarpal bone of the index; the ſecond (EPICONDYLO-SUPER-METACARPALIS,) into that of the middle finger.

B. *In other Mammiferous Animals.*

Monkies have, like man, five muſcles of the hand. The *cat* and the *bear* have the ſame number.

The *dog* has only one *radialis externus*, which divides into two tendons. It is the ſame with reſpect to the *rabbit*.

In all thoſe, with many fingers, the external muſcles, when acting in concert, approximate the back of the hand to that of the fore-arm.

The internal muſcles have a different effect. When the ulnar act in concert, the hand is turned outward towards the ulnar ſide of the fore-arm. The radial produce a contrary motion.

In animals that have cannon-bones, in which the hand is neither capable of flexion or extenſion, the *radialis externus*, (*extenſor rectus anticus of the cannon-bone* of Bourgelat,) is fixed to the anterior baſe of the metacarpus, or cannon-bone, and extends it.

The *radialis internus*, (*flexor internus* of Bourgelat,) is inſerted into the poſterior baſe. The *ulnaris internus*, (*flexor obliquus* of Bourgelat,) is inſerted in the bone that correſponds to the os piſiforme. The *ulnaris externus*, (*flexor externus* of Bourgelat,) is inſerted in the ſame bone, and extended under thoſe of the carpus.

Theſe muſcles are all flexors.

The muſcles which move the hands of *bats* are few in number, but they are very remarkable.

That which is analogous to the *ulnaris externus*, ariſes from the humerus, and from the convexity of the radius as far as its middle. Its tendon is inſerted into the ſuperior and internal part of the carpus, which it extends by abduction.

The muſcle which correſponds to the *ulnaris internus*, ariſes from a fleſhy portion common to all the muſcles of the fore-arm, and is inſerted into the external ſide of the firſt phalanx of the laſt finger. It is a flexor or adductor of the carpus.

That which takes the place of the *adductor pollicis*, ariſes alſo from the ſame common fleſhy maſs. Its tendon proceeds obliquely to the ſuperior ſurface of the fore-arm, croſſing the tendon of the ulnaris externus. It is inſerted in the internal ſide of the carpus, at the baſe of the thumb.

C. *In Birds.*

The metacarpus of Birds is not capable of flexion, or approaching the internal ſurface of the fore-arm; nor of extenſion, or approaching the external ſurface of that arm. It can only perform the motion of adduction by approximating the radius and abduction, by coming nearer the ulna. As there are, however, only theſe two motions, we might, in imitation of

Vicq D'Azyr, call the muſcles that produce them flexors and extenſors: But as it will be more eaſy to compare them to thoſe of man, we ſhall retain the common names.

The *ulnaris internus* has the ſame poſition as in Mammalia. It originates in the ſame manner from the internal condyle of the humerus, and is inſerted into the tubercle of the bone that reſembles a wedge. There is a ſmall muſcle under the preceding to which it is parallel. It produces a long tendon, which ſends off ſlips to the ſecondary quills, and is inſerted in the back of the metacarpus.

The *ulnaris externus* is placed on the poſterior ſurface of the ulna. Its tendon paſſes between the firſt ſecondary quill and the laſt primary, and is inſerted in the internal edge of the baſe of the metacarpal bone.

There is but one *radial* muſcle, but it conſiſts of ſeveral portions, which all ariſe from the external condyle, except one from the radius. Their common tendon is inſerted into the tubercle of the metacarpal bone of the thumb: this tubercle, as we have obſerved, is ſometimes a ſmall ſeparate bone.

D. *In Reptiles.*

In the *ſea-tortoiſes*, which have the carpus compreſſed, and fitted for ſwimming, the muſcles are only ſimple bands of aponeurotic fibres, which ſtrengthen the ſeveral articulations.

We have ſtill to examine thoſe of the other reptiles.

II. MUSCLES OF THE FINGERS.

The muſcles of the fingers are *extenſors* and *flexors*, *adductors* and *abductors*. They are common or proper, and long or ſhort, according as they are ſituated along the fore-arm, or proceed merely from the carpus and metacarpus.

A. *In Man and other Mammiferous Animals*,

The long muſcles of the fingers are,

1. THE EXTENSORS.

Theſe are ſituated on the external ſurface.

The EXTENSOR COMMUNIS, (EPICONDYLO-SUPER-UNGUIALIS,) ariſes from the external condyle of the humerus. It ſends off tendons to all the fingers except the thumb, and is found in all quadrupeds. The number of its tendons is equal to that of all the fingers, the thumb not included. In general they are four; but in the Ruminantia they are two; and in the Solipeda only one, which is the *extenſor anticus* of Bourgelat, and the *extenſor pedis* of La Foſſe.

The EXTENSOR PROPRIUS DIGITI MINIMI, (EPICONDYLI-SUPER-UNGUIALIS,) is placed on the ulnar ſide of the preceding, and has the ſame origin. In man it has a tendon for the little finger only. In *monkies* it has another for the fourth. In *dogs* and *bears* it ſends off a third to the middle finger. Inſtead of one muſcle, the *cat* has two; one for the little or laſt finger, and one for the fourth and third. There is but one muſcle in the *rabbit*, which has two tendons, as in the *monkey*.

In the Ruminantia this muſcle extends the external toe, and the *extenſor indicis* the internal toe.

There are two muſcles in the *horſe*; one more removed from the *extenſor anticus*, analogous to to the extenſor communis. It is called *extenſor lateralis* by Bourgelat, and *extenſor of the paſtern* by La Foſſe. Its tendon is inſerted into the ſide of the firſt phalanx of the toe. A ſecond is placed between the two, and its tendon, after having paſſed before the carpus, is obliquely united with that of the preceding muſcle. The hippotomiſts conſider this tendon as a digitation of the extenſor anticus.

The extensor indicis proprius, (cubito-super-unguialis,) is ſituated cloſe to the inferior and external part of the ulna in man. It has only one tendon, which is inſerted into the fore-finger; but it is ſometimes accompanied by a proper extenſor for the middle finger.

In *monkies* it has two tendons; one for the index, and another for the middle finger.

In the *dog* and *cat* it is ſituated as in man, but it extends to the laſt articulation. It is entirely wanting in the *rabbit*, the Ruminantia, and the *horſe*.

The thumb has two *extenſores proprii.*

The LONGUS (CUBITO-SUPER-PHALANGEUS,) is placed above the extenſor of the fore-finger. It paſſes under the external annular ligament, and extends its tendon to the firſt phalanx.

The BREVIS (CUBITO SUPER-UNGUIALIS,) is placed on the radial ſide of the preceding muſcle. Its tendon accompanies that of the abductor, and extends to the ſecond phalanx.

In *monkies* the laſt muſcle either intimately unites its tendon with that of the abductor, or is altogether wanting.

The *extenſor brevis pollicis* is wanting in the *cat*, the *dog*, the *bear*, and the *rabbit*. The *longus* exiſts in theſe ſpecies, and in the *bear* gives a tendon to the fore-finger.

The Ruminantia and the *horſe* have neither.

2. THE ABDUCTORS.

The ABDUCTOR POLLICIS LONGUS (CUBITO SUPER-METACARPALIS,) is placed above the preceding muſcles, towards the radial ſide of the fore-arm. It croſſes the radial muſcles at the inferior head of the radius, and is inſerted in the radial ſide of the metacarpal bone of the thumb.

This muſcle is ſimilar in *monkies, dogs, cats, bears, rabbits*, &c.

In the *horſe*, and in the Ruminantia, it is attached to the internal ſide of the baſe of the only metacarpal bone, and becomes what Bourgelat calls the *oblique extenſor of the cannon-bone.*

3. THE FLEXORS.

Theſe are all on the internal ſurface of the fore-arm.

The FLEXOR SUBLIMIS (EPITROCHLO-PHALANGEUS,) conſiſts of ſeveral diſtinct muſcles, which unite in different ways, and terminate by furniſhing tendinous perforated ſlips to the fingers which follow the thumb.

The FLEXOR LONGUS POLLICIS (RADIO-SUB-UNGUIALIS,) appears to be united to the former in a very intimate manner. It is ſituated on its radial ſide, and is extended to the ſecond phalanx.

The FLEXOR PROFUNDUS (CUBITO-SUB-UNGUIALIS,) which is ſituated upon the bones of the fore-arm, tranſmits perforating tendons to the four fingers which follow the thumb: ſuch is the deſcription of theſe muſcles in the human body.

In *monkies* the *flexor longus pollicis* is wanting; but the *profundus* divides into five ſlips, one of which proceeds to the thumb, to which the ſublimis does not ſend any tendon.

In the *dog* the *flexor pollicis* unites its tendon with that of the *profundus*, from which it again ſeparates to proceed to the ſecond phalanx of the thumb.

The *flexor ſublimis* ſends a tendon to the firſt phalanx of the thumb, but it is not perforated.

It is the ſame with reſpect to the *cat*; but the *flexor pollicis* is not in this animal ſo diſtinct from the *profundus*, which, beſides, is viſibly divided into as many muſcles as it produces tendons.

The *profundus* in the *rabbit* tranſmits a tendinous ſlip to the thumb, which is not the caſe with reſpect to the *ſublimis*.

In the Ruminantia the *flexor ſublimis* and the *profundus* tranſmit two tendons each, and the tendon of the *flexor pollicis* is united with that of the *flexor profundus*.

There are likewiſe two of theſe muſcles in the *horſe*, one perforating and the other perforated, but which have each only one tendon.

B. *In Birds.*

As the fingers of birds can perform no motions except thoſe of adduction and abduction, the uſe of the preceding muſcles is changed in the animals of this claſs. Theſe two functions are diſtributed among the muſcles without any uniform relation to the ſide of the fore-arm to which they adhere. If, therefore, we were to ſubſtitute for the term *adduction* that of *extenſion*, and for *abduction* that of *flexion*, which might be done, ſtill the flexors would not all be placed on the internal, nor the extenſors all on the external ſurface of the arm. In this manner, indeed, the muſcles which are flexors in man would be converted into extenſors.

1. THE ADDUCTORS, *or* EXTENSORS *of Vicq D'Azyr.*

The *adductor phalangis primæ* correſponds to the *flexor ſublimis*. It ariſes from the internal condyle, proceeds above the ulnaris internus, paſſes over the internal ſide of the wedge bone along the metacarpal bone, and is inſerted into the baſe of the firſt phalanx of the great finger.

The *adductor internus phalangis ſecundæ*, which correſponds to the *flexor profundus*, proceeds along the internal ſide of the ulna. Its tendon approaches that of the preceding muſcle, but proceeds farther, and is inſerted into the baſe of the ſecond phalanx. There is no perforation.

The *adductor pollicis*, which correſponds to the *flexor pollicis*, is ſituated between the preceding muſcle and the ulna. Its tendon extends to the radial edge of the thumb.

The *adductor externus phalangis ſecundæ* is analogous to the *flexor proprius indicis*. It is attached to the external condyle, and ſituated along the external ſide of the radius. Its tendon paſſes to the back of the metacarpus, and even extends to the ſecond phalanx of the great finger.

2. THE ABDUCTORS, *or* FLEXORS *of Vicq D'Azyr.*

The *abductor communis*, which correſponds to the *extenſor communis* in man, ariſes from the external condyle, and proceeds without the preceding muſcle, along the external ſide of the radius. When its tendon arrives oppoſite to the carpus, it divides into two. One goes to the ulnar baſe of the thumb, the other to that of the firſt phalanx of the great finger.

IV. SHORT MUSCLES OF THE FINGERS.

The hand of man has alſo a great number of ſhort muſcles which ariſe from the bones of the carpus or metacarpus, and are inſerted into the fingers.

One of them is ſuperficial: it is placed under the ſkin of the palm of the hand, to which it is attached on one part, and on the other to the palmar aponeuroſes. It is called CARO-QUADRATUS, and PALMARIS CUTANEUS (PALMO-CUTANEUS.)

Of the other muſcles, ſome belong to the thumb; as—

The ABDUCTORB REVIS, (CARPO-SUPER-PHALANGEUS.) It ariſes from the trapezium, and is inſerted in the external ſide of both phalanges of the thumb.

The FLEXOR BREVIS (CARPO-PHALANGEUS,) ariſes from almoſt the whole of the inferior ſurfaces of the bones of the carpus, and is inſerted into the firſt phalanx.

The OPPONENS (CARPO-METACARPALIS,) ariſes from the ligament of the carpus, and from the os trapezium, and is inſerted in the metacarpal bone of the thumb.

The ADDUCTOR (METACARPO-PHALANGEUS,) extends from the firſt and ſecond bones of the metacarpus to the firſt phalanx of the thumb.

The little finger has alſo two ſmall muſcles which are peculiar to itſelf, viz.

The FLEXOR BREVIS, or OPPONENS, (CARPO-METACARPALIS,) ariſes from the os unciforme, and is inſerted into the internal ſide of the metacarpal bone. It renders the palm of the hand concave, and bends the little finger.

The other is the ADDUCTOR, (CARPO-PHALANGEUS.) It ariſes alſo from the os unciforme, and is inſerted into the external ſide of the firſt phalanx.

Laſtly, there are ſome ſmall muſcles of the hand which are common to all the fingers: Theſe are—

The LUMBRICALES (PALMO-PHALANGEI,) which are four in number. They ariſe from the tendons of the flexor profundus, and are inſerted in the internal ſides of the firſt phalanges of the fingers, except the thumb. They are auxiliaries to the flexor profundus.

The INTEROSSEI INFERIORES *ſeu* INTERNI, *et* SUPERIORES *ſeu* EXTERNI, (METACARPO-SUPER-PHALANGEI.) Theſe muſcles occupy the intervals between the metacarpal bones, and are inſerted into the two ſides and upper part of the firſt phalanx of each finger.

The *bats* have only one extenſor, and ſome flexors of the fingers.

The *extenſor digitorum* is a ſmall muſcle which comes from the external condyle of the humerus, paſſes to the carpus, and produces a very fine tendon, which extends to the convexity of each of the phalanges, and is terminated in the laſt.

The *flexor communis* ariſes from the fleſhy maſs on the inner ſide of the fore-arm. It produces a ſlender tendon, which paſſes under the carpus, where it divides into five ſmall ſlips, which afterwards unite with the proper flexor of each of the fingers.

Laſtly, the *flexores proprii*, which are four in number, ariſe from the carpus at the baſes of the firſt phalanges. They there form a ſmall fleſhy body, which receives the tendon of the flexor communis, and is continued with it to the extremity of the finger, the phalanges of which it bends one over the other.

The thumb appears alſo to have ſome ſmall peculiar muſcles. Their ſhort fibres ariſe from all the palmar ſurface of the carpus, and form a little pyramid, the apex of which is inſerted into the baſe of the firſt phalanx.

In the Cetacea the above muſcles are only ſimple aponeurotic bands fitted for connecting the rudiments of bones, which in them do not move one upon the other.

C. *In Reptiles.*

The muſcles of the hand of the *frog* and the *ſalamander* are very ſimilar to thoſe of man.

Thoſe of the thumb are wanting, except the *extenſor*, which comes from the external condyle, and is inſerted in the laſt phalanges.

There is an extenſor of the two laſt fingers, which alſo ariſes from the external condyle, and is inſerted into the laſt phalanges.

The other muſcles vary very little.

In *ſea tortoiſes* the muſcles of the hand are replaced by bundles of aponeurotic and tendinous fibres, which ſupport the articulations in the action of ſwimming.

We have not yet had an opportunity of ſtudying thoſe muſcles in the other reptiles.

TABLE of the Length, in Metres, of the different Parts of the Pectoral Member in Mammalia.

NAMES	Total	Arm	Fore Arm	Carpus	Meta-carpus	Fingers
Man	0,79	0,33	0,26	0,03	0,07	0,10
Sai	0,28	0,10	0,11	0,01	0,02	0,04
Orang	0,38	0,12	0,14	0,01	0,04	0,07
Pongo	1,00	0,35	0,38	0,03	0,10	0,14
Ternate Bat	0,575	0,11	0,15	0,015	0,11	0,19
Common Bat	0,19	0,035	0,06	0,005	0,05	0,04
Mole	0,105	0,02	0,02	0,05	0,015	
Hedge-hog	0,14	0,04	0,04	0,03	0,015	0,015
Sea-Bear	0,88	0,30	0,33	0,03	0,10	0,12
Glutton	0,34	0,12	0,12	0,01	0,03	0,06
Racoon	0,33	0,10	0,13	0,01	0,03	0,06
Otter	0,24	0,09	0,08	0,01	0,03	0,03
Seal	0,30	0,08	0,11	0,02	0,02	0,07
Lion	0.85	0,31	0,30	0,03	0,10	0,11
Cat	0,27	0,09	0,11	0,01	0,03	0,03
Wolf	0,53	0,18	0,19	0,02	0,07	0,07
Opoſſum	0,19	0,06	0,08	0,01	0,02	0,02
Hare	0,29	0,10	0,12	0,01	0,03	0,03
Guinea Pig	0,11	0,04	0,04	0,01	0,01	0,01
Three-toed Sloth	0,51	0,19	0,18	0,01	0,03	0,10
Long-tailed Manis	0,15	0,05	0,05	0,005	0,01	0,04
Elephant	1,53	0,77	0,48	0,11	0,10	0,07
Hog	0,67	0,20	0,24	0,04	0,09	0,10
Rhinoceros	1,42	0,46	0,53	0,08	0,20	0,15
Dromedary	1,49	0,35	0,57	0,06	0,30	0,21
Giraffe	2,44	0,51	0,91	0,08	0,72	0,22
Ox	1,00	0,26	0,34	0,04	0,18	0,18
Stag	1,10	0,25	0,38	0,04	0,27	0,16
Horſe	0,92	0,22	0,34	0,04	0,18	0,14
Dolphin	0,22 in all					
Porpoiſe	0,18 in all					

ARTICLE IX.

ARTICLE IX.

Of the Anterior Extremity in Fiſhes.

1. *Of the Bones.*

THE anterior extremities of fiſhes are their pectoral fins. Theſe, like all the other fins, are compoſed of a certain number of oſſeous radii or fibres, each formed of a multitude of joints, and ſuſtaining a common membrane. Sometimes one or two of theſe radii or rays are made of a ſingle bony piece. Theſe are called ſpinous.

In moſt fiſhes the pectoral fin moves in a horizontal plane, which is nearly perpendicular to its own plane; that is to ſay, in the ſtate of repoſe it is placed cloſe to the ſide of the body, from which it may be raiſed to a greater or leſs height, until it forms a right, or even an obtuſe angle with the ſide.

In others, as the *rays*, the *ſharks*, &c. the two pectoral fins are in the ſame horizontal plane; when they move, they ſtrike from above downward, or from below upward, preſerving a vertical direction.

The pectoral fin is wanting in only a very ſmall number of fiſhes, ſuch as the *eels* and *cecilias*.

In thoſe which have the pectoral fin, it is generally articulated and firmly attached to the head, as in *oſſeous fiſhes*, or to the ſpine, as in *rays*, &c.

The pectoral fins in *rays* form thoſe large wings which give to the body a rhomboidal ſhape. They are formed of a vaſt number of radii, placed very cloſe together, and having a number of articulations. They are all connected with a cartilage parallel to the ſpine, which may be ſubdivided into two or three, and which is itſelf articulated, on the upper part, to another cartilage fixed to the ſpine. Beneath there is a ſort of tranſverſe bar, common to the cartilages of both fins, and which ſerves at once for ſternum and clavicles. This inferior bar alſo exiſts in *ſharks*; but we obſerve in them no articulations with the ſpine. Their pectoral fins are much ſmaller.

In the *oſſeous fiſhes*, and in ſeveral others which ſhould be regarded as belonging to that claſs, though Ichthyologiſts have ranged them among the cartilaginous, (ſuch as the *baliſtes*, &c.) the pectoral fins are attached to an oſſeous girdle which ſurrounds the body behind the branchiæ, and which ſupports the poſterior edge of their aperture.

This oſſeous girdle is formed of one bone from each ſide, articulated at the poſterior ſuperior angle of the cranium, and deſcending under the neck, where it unites with the correſponding bone. Theſe bones may be regarded as *ſcapulæ*. The portion ſituated above the fin is ſimple and thin; that which is beneath has anteriorly a projecting plate which anſwers inſtead of a ſpine. The abductor muſcles lie in the angle formed by this lamina with the body of the bone.

The portion of the body of the bone, which is ſituated behind the lamina, is more or leſs large according to the extent of the muſcles. At this place there is ſometimes an unoſſified interval. This is the caſe in the *flying trigla*, in the *zeus*, &c. The *ſea dragon* and the *whiting* have two of theſe intervals.

The lamina is extremely broad in the *chætodons*, the *zeus*, and the *ſea-wolf*.

The figure of this bone, the angle under which it joins its correſponding bone, and thoſe which interſect it, vary in the different ſpecies. In the fiſhes, compreſſed vertically, they unite by a ſharp angle. In thoſe that are depreſſed they are turned inwardly in ſuch a manner that their union forms almoſt a right line.

In a number of fiſhes, particularly in thoſe of the family Thoracici, viz. the genera *pleuronectes*, *perches*, *cottus*, *zeus*, *chætodons*, &c. as well as in the *baliſtes*, and ſeveral others, the ſuperior part produces a large ſpine, which deſcends directly behind the fin, and ſerves for the attachment of the *adductor* muſcles. This ſpine is moveable, and has, by ſome anatomiſts, been improperly called the *clavicle*.

The rays which ſuſtain the membrane do not articulate immediately with the bony girdle. Between them and it there is a range of ſmall flat bones, ſeparated by cartilaginous intervals, which may be compared to the bones of the carpus. There are four of theſe bones very large in the *ſea wolf*, the *red gurnard*, the *armed* and the *flying trigla;* four ſmall ones in the *whiting* and the *pleuronectes;* eight in two rows in the *dory*, *(zeus faber;)* three ſmall and cylindrical in the *ſilurus*; and five in the *chætodons*, *perches*, &c. When the firſt ray of the pectoral fin is ſpinous, as in the *loricaria*, ſome *ſiluri*, &c. it is immediately articulated with the girdle bone.

This diſpoſition is remarkable in ſome *ſiluri* and ſome *ſticklebacks*, which can, at pleaſure, either lay this ſpine flat upon the body, or place it firmly ſupported in a perpendicular poſition. They are thus furniſhed with an excellent means of defence.

The oſſeous girdle has for this purpoſe a tubercle of a cylindrical form, in the front of which there is a hole. The ſpine of the fin articulates with this cylinder by a depreſſion, which has a projecting proceſs before and behind it. When the ſpine is extended, the anterior proceſs, which is in the form of a hook, enters the above-mentioned hole, and the ſpine turning a little on its axis, the proceſs is hooked upon the edge of the hole in ſuch a manner that the ſpine cannot be inflected until it makes a turn upon its axis in a direction oppoſite to the former. This ſpine is furniſhed with denticulations, which form a part even of the ſubſtance of the bone. They have oppoſite directions upon the two ſides of the *ſilurus aſpredo*, and upon one ſide only in the *ſilurus felis*, *ſiluris galeatus*, and many others.

In the *trigla hirundo*, *volitans* and *evolans*, *ſcorpæna volitans*, *exocœtus volitans*, and ſome other fiſhes, the pectoral fins are exceedingly long, and ſerve for flying.

Their ſituation varies conſiderably in different ſpecies: they are very near the branchiæ in the *exocœti:* on the contrary, they are conſiderably removed from them in the *blennies*, &c.

2. *Of the Muſcles.*

The pectoral fin of the oſſeous fiſhes is firmly ſupported by the flat bone, which is articulated with the poſterior angle of the cranium, and which correſponds with the ſcapula. Two ſtrong muſcles ariſe from the inferior or broadeſt part of this ſpecies of ſcapula, and are inſerted in the enlarged or poſterior extremity of the cordiform bone which ſupports the tongue. Theſe are analagous to the *ſterno-hyoidæi*.

Another muſcle, which performs the office of the *diaphragm*, and which ſeparates the cavity of the branchiæ from that of the abdomen, is attached, at the one part, to the point of the bone which ſuſtains the branchiæ, and, at the other, to the internal creſt of the baſe of the ſcapula.

The clavicle is alſo moved by a ſmall muſcle, which ariſes from its free extremity, and is inſerted partly into the ſcapula, and partly loſes itſelf in the muſcles that cover the belly.

But the fin is particularly moved upon the ſcapula by two ſets of muſcles. One ſet being ſituated at its external and inferior ſurface, and the other at the internal and ſuperior ſurface.

The firſt external muſcle covers all thoſe of the ſame ſurface. It occupies the anterior part of the infraſpinous foſſa, and is inſerted by a great number of tendinous digitations into each of the eminences of the rays of the fin. This muſcle raiſes the fin from the flank, and moves it forward, making it cut the water.

The firſt being removed, we find two other muſcles; one is more internal, and its fibres, which are directed obliquely outward, terminate likewiſe by ſmall tendons in each of the rays. It lowers the fin, moves it towards the correſponding fin, renders it vertical, and turns it downward.

The third muſcle is more external: it ariſes from almoſt the whole breadth of the foſſa; but it diminiſhes in breadth as it approaches the fin, and terminates at laſt by being inſerted in the moſt external of the rays. By its contractions it removes the fin from the body, and directs it towards the head, making it ſtrike the water.

The muſcles of the internal ſurface are likewiſe diſpoſed in layers. The largeſt and moſt external extends from the ſuperior ſpine of the ſcapula, which is articulated with the cranium, to the baſe of the radii of the fin. It is conſiderably augmented in its progreſs, and it is croſſed by the clavicle. It turns the plane of the fin directly outward, by removing it from the body. This muſcle covers another at its inferior part.

This laſt muſcle has a number of fibres. It occupies all the part of the ſub-ſcapular foſſa, which is ſituated under the clavicle. It performs preciſely the ſame office as the preceding, but moves the plane of the fin ſomewhat more towards the head. There are more of its muſcular fibres attached to the baſes of the radii. Their different directions approximate or remove, with reſpect to each other, all thoſe little bones, ſo as to ſpread out or cloſe the kind of fan which they conſtitute.

The muſcles of the pectoral fins of the *ray* form two very thick fleſhy layers, which cover thoſe fins ſuperiorly and inferiorly, and which are divided into as many bundles as the fins are into radii.

LECTURE FIFTH.

OF THE POSTERIOR EXTREMITY, OR ABDOMINAL MEMBER.

ARTICLE I.

Of the Bones of the Pelvis.

A. *In Man.*

THE pelvis in man is a kind of oſſeous girdle ſurrounding the lower part of the trunk obliquely, and ſo ſituated that its poſterior part, which is ſtrongly attached to the ſides of the os ſacrum, is more elevated, and its anterior part lower than that bone.

The ſuperior and poſterior part is compoſed of two wings, of a form almoſt ſemicircular. The anterior and concave ſurface of each is turned ſomewhat inward, and the poſterior and convex ſurface is extended towards the ſpine, where it furniſhes the portion which is attached to the os ſacrum.

The lower part of each of theſe wings is narrowed into a kind of neck, and prolonged ſomewhat inferiorly, as far as the great hemiſpherical depreſſion, called the *cotyloid* cavity, which ſerves to lodge the head of the femur. One branch, which proceeds from the anterior edge of this cavity, is directed forward and inward until it meets the correſponding branch of the other ſide, and completes the anterior portion of the pelvis. Another branch proceeds from the inferior edge of the ſame cavity. It is directed downward in ſuch a manner as to leave between it and the ſacrum a large ſpace, called the *iſchiatic notch*. Having deſcended a little lower than the coccyx, this branch aſcends by a direction which is forward and inward, until it unites to the firſt branch, at the place where it joins the correſponding one from the oppoſite ſide. Thus there remains, on each ſide of this anterior part of the girdle formed by the pelvis, an interval ſurrounded by an oſſeous circle, and named the *oval*, or *ſub-pubic foramen*.

The plane of each half of this anterior portion is turned obliquely downward and to one ſide. The ſuture which ſeparates the two halves anteriorly, is called *ſymphyſis pubis*. The two bones which with the os ſacrum form the pelvis, are called *coxæ*, *haunch bones*, or *oſſa innominata*.

In youth each of theſe bones is divided into three parts, all of which contribute to the formation of the *cotyloid* cavity. They have been long regarded as particular bones, and have received different names, viz. 1. The *os ilium*, or flank bone, which is the ſuperior portion, in the form of a wing; its ſuperior and ſemicircular edge is called the *criſta* of the *os ilium*; and the angle produced at its junction with the inward curvature, which aſſiſts in forming the before mentioned neck, is called the *ſpine*. 2. The *os pubis*, which forms the anterior tranſverſe bar, and the portion which deſcends the whole length of the ſymphyſis. 3. The *os iſchium*, which ſurrounds the foramen ovale poſteriorly and inferiorly. Its moſt inferior portion is called the *tuberoſity* of the *iſchium*, and it is on this part of the bone we reſt in ſitting. The margin of this laſt portion, which is turned towards the os ſacrum, has, at the height of the cotyloid cavity, a ſmall hooked proceſs directed backward: this is called the *iſchiatic ſpine*.

The ſuperior margin of the os pubis is continued on the inferior part of the internal ſurface of the os ilium in an elevated bone line, which extends to the place where the latter bone joins the os ſacrum; and which, together with the projection the os ſacrum itſelf forms at its angle with the reſt of the ſpine, divides the pelvis into two parts: the *great pelvis*, which is ſuperior; and the *little pelvis*, which is inferior.

This inward projection is called the *anterior ſtrait of the pelvis*. It forms a kind of ellipſis, the plane of which makes a very marked angle with the ſacrum, and another with the lumbar part of the ſpine. Its diameter between the anterior and poſterior part is ſomewhat leſs than that between the ſides.

The bones which form the pelvis are united by very ſtrong ligaments, ſome of which contribute to the formation of its cavity. Thoſe which unite the ileal portion of the os innominatum to the ſacrum, come from the tranſverſe proceſs of the laſt lumbar vertebra, or the baſe and proceſſes of the os ſacrum. The bundles which they form are more or leſs long, and extended. They are inſerted in the poſterior part of the creſt of the os ilium.

The iſchiatic portion is alſo united by two ſtrong ligaments, which complete the cavity of the little pelvis poſteriorly. One extends from the tuberoſity to the lateral margin of the ſacrum. The other ariſes alſo from the iſchium, but particularly from its ſpine, and extends tranſverſely to the margins of the ſacrum and coccyx, uniting its fibres with thoſe of the preceding ligament.

The os pubis of the one ſide is joined with that of the other by an intermediate cartilage, which forms what we have called the ſymphyſis. This articulation is covered with a ſtrong ligament, which renders it immoveable.

Finally, the bones of the tail or coccyx are firmly united to the os ſacrum by articular capſules and ligaments, which cover them entirely. Theſe are divided into the anterior, the lateral, and the poſterior.

B. *In other Mammiferous Animals.*

We have obſerved, that, in *quadrupeds*, the ſacrum is commonly continued in the ſame line with the ſpine. It may be farther remarked, that were we to place them ſo as to render their ſpine vertical, the planes of the two anterior halves of the pelvis would be directed forward and outward, and not downward as in man: they would even be turned upward in hoofed animals. Hence it follows, that if theſe planes were continued, they would meet a prolongation of the ſpine below the pelvis in man, above it in hoofed animals, and that they would remain parallel to the pelvis in the greater number of animals with claws. This obſervation is important, on account of the poſition of the femur.

The oſſa ilii of *monkies* are narrower, flatter, and directed more forward than thoſe of man. Their neck is longer. It follows, that the plane of the pelvis is almoſt in a ſtraight line with the ſpine, and that the diameter from before backward is greater than the tranſverſe. The pelvis therefore furniſhes a much ſmaller baſe to the trunk than in man; for this baſe muſt be eſtimated by a perpendicular ſection of the trunk, or cylinder to which it belongs.

The *batavian pongo* has the oſſa ilii much broader than the other *monkies*, but their poſition is as deſcribed above.

The ſpecies of *monkies* which have calloſities on the buttocks have very large tuberoſities to the iſchium.

In the Carnivora, the abdominal ſurface of the bones of the ilium is not turned forward, but towards the spine. Their ſuperior portion is not broader than their neck; it is their external ſurface which is concave. Their criſta has ſo little extent, that the figure is almoſt that of a hatchet.

In the *bear* it is somewhat larger, and the ſpine is turned outward; but the poſition upon the whole remains the ſame. The branch of the iſchium which runs backward is continued with the neck of the ilium in a ſtraight line which forms an angle of about thirty degrees with the ſpine. As the diameter from the front to the back of the anterior *ſtrait* of the pelvis is ſhorter than in *monkies*, its particular proportions have more reſemblance to those of man, but the baſe it affords to the trunk is notwithſtanding ſmaller.

We obſerve among the Carnivora two remarkable anomalies. One in the *mole*, in which the oſſa innominata are almoſt cylindrical, and ſituated ſo cloſe to the ſpine throughout the whole of their length, that the anterior ſtrait is exceedingly ſmall. The iſchiatic portion is alſo very much prolonged poſteriorly: the other appears in the *ternate bat*, which has the tuberoſities of the iſchium joined to each other and to the extremity of the ſacrum by anchyloſis.

In the Pedimana, or the animals with a pouch, as the *opoſſum*, the *marnot*, the *kanguroo*, &c. the pelvis is likewiſe very remarkable, in having the foramen ovale very large, and the diameter of the *ſtrait* ſmall, but more ſo from the preſence of an articulated and moveable bone upon the pubis. This bone gives origin to particular muſcles which ſupport the pouch that contains the mammæ. This ſhall be farther deſcribed in the article on Generation. Bones of this kind are called *marſupial*, they are of an oblong form ſomewhat compreſſed.

In the Rodentia, the general form and poſition of the pelvis is nearly the ſame as in the Sarcophaga. The oſſa ilii are turned more or leſs forward, or rather downward, according to the different ſpecies: the projecting line of their abdominal ſurface is continued parallel to the ſpine, as far as their creſt, which is very narrow. This elevation ſometimes gives to theſe bones the form of a priſm, in which their real margin is only an edge; their ſpine is reflected outward.

This is alſo the form of the oſſa ilii in the *armadillos*, *pangolins*, and *ant-eaters*; while the *sloths* have them very broad, and directed forward with a large circular pubis: this renders their ſtrait or opening very wide, and little oblique. As theſe four genera have the tuberoſity of the iſchium approximated, or even oſſified to the os ſacrum, they have only a hole inſtead of the iſchiatic notch.

The pelvis of the *hog* differs very little from that of the Sarcophaga, except that the bones of the iſchium extend farther backward, and that the iſchiatic notch penetrates farther into the os ilium.

In the *tapir*, and more particularly in the Ruminantia, the notch being ſtill more enlarged, the neck of the ilium elongated, and its ſpine extended outward, this bone aſſumes the form of the letter T, or a hammer, articulated by one branch to the os ſacrum, and the neck forming the handle. Its abdominal ſurface is turned obliquely towards the ſpine of the back: its neck forms a very obtuſe angle with the iſchium. We can obſerve the projection of its ſpine under the ſkin, and alſo the iſchiatic tuberoſity, the line which paſſes through theſe two points forms a very diſtinct angle with the ſpine. The cotyloid cavity is nearly in the middle of that line.

In the Ruminantia that are very ſtrong backed, like the *ox*, the anterior part of the ilium is exceedingly large. In the *buffalo* it is even broader than the bone is long, and almoſt perpendicular to its neck. In the ſmaller ſpecies it becomes more and more narrow and oblique, outward and anteriorly. The *camel* has it rounded. The external ſurface of the bone is concave in theſe animals. The anterior ſtrait of the pelvis forms a large a large angle with the ſpine of the back, which affords more room for the belly.

The figure of this bone is nearly the ſame in the *horſe*; but the wings are very large, and the neck very short. The cotyloid cavity correſponds nearly with the poſterior third of the above-mentioned line.

The *elephant* and the *rhinoceros* have the anterior part very broad in every direction. The crest is round, and the abdominal ſurface is concave. The wing next the ſacrum is larger than the other in the *elephant*. In the *rhinoceros* they are nearly equal, and the neck is proportionally longer. Theſe enormous pelves give to the bellies of thoſe animals that vaſt capacity for which they are ſo remarkable. The plane of the anterior ſtrait is almoſt perpendicular to the ſpine.

The pelvis of *seals* resembles that of the Carnivora, and particularly the *otters*; it is very long and narrow, and the pelvis, as in the *otter*, is inflected conſiderably backward; but the only veſtige of a pelvis to be found in the Cetacea conſiſts of two thin flat bones, ſuſpended in the fleſh, on both ſides of the anus.

C. *In Birds.*

The oſſa innominata form, with the lumber vertebræ and the ſacrum, only one bone in birds. They exhibit therefore only the lineaments of the pelvis. In general, however, we obſerve the foramen ovale in the ſkeleton. As the iſchiatic portion is almoſt always intimately united with the ſacrum, the iſchiatic notch becomes a hole. The pubis of the one ſide, inſtead of joining its correſponding bone, proceeds directly backward in the form of a style.

In young birds, the bone analogous to the os ſacrum is completely perforated between the tranſverſe proceſſes of the vertebræ, of which this bone is originally conſtituted. The oval and iſchiatic foramina are at that time only two notches, which very diſtinctly indicate the three portions of the os innominatum.

In Birds of Prey, the foramen ovale is ſmall, and the os pubis very thin, long, and frequently articulated with the iſchiatic portion.

In the Paſſeres, the foramen ovale is conſiderably lengthened, and is larger than the iſchiatic hole. This elongation is ſtill more obſervable in the Grallæ.

The *diver* has the os ilium extremely ſmall; the iſchium, which is very bulky, is intimately united by oſſification throughout all its length with the os ſacrum. The oſſa pubis are very thin; they are conſiderably enlarged where they meet, but they are not completely oſſified together. This may be remarked, in general, of all *water birds*.

In the *oſtrich* and the *caſſowary* the iſchium is altogether ſeparate from the coccyx, which unites with a long production of the ilium. The inferior part of the pubis is conſiderably enlarged, and curved, in order to unite with the correſpondent bone in the *oſtrich*, but not in the *caſſowary:* beſides, the oſſa iſchii are in the latter entirely ſeparate from the pubis, and placed in the ſame direction.

D. *In Reptiles.*

In the *turtle*, that part of the os innominatum which correſponds to the pubis, is the moſt conſiderable. It proceeds from the cotyloid cavity, by a thick portion, which comes forward and widens into a thin flat lamina, divided into two parts: one is turned towards the middle line, by which the two correſponding bones are united; the other is free, and is directed to the external ſide. The portion which correſponds with the ilium is ſhort, narrow and thick; it reſts on the ſhell, and is joined to the ſacrum: finally, the portion which is analogous to the iſchium, is turned backward and downward, and forms the real oſſeous circle of the pelvis.

This conformation is ſo ſingular, that the parts of the pelvis of the *turtle*, when the whole is viewed out of its natural poſition, may very eaſily be miſtaken for one another; for the pubis reſembles the ilium, the iſchium the pubis, and the ilium the iſchium.

There is, beſides, another very remarkable peculiarity in the pelvis of *tortoiſes;* the ilium, and conſequently the whole maſs of the pelvis with which that bone is united, is moveable on the vertebral column.

In the *crocodile* and the *tupinambis*, the diſpoſition of the pelvis has a great reſemblance to that of the *tortoiſe.* In the *crocodile* the pubis receives the ventral ribs. In the *cameleon* and the *iguana* it is narrow, and the bones of the iſchium form by this union a projecting creſt.

In the *frog*, and in the *Surinam* and *common toads*, the oſſa ilii are much elongated: the pubis and the iſchium are ſhort, and united in a ſingle ſolid piece, the ſymphyſis of which forms a creſt more or leſs round.

In the *ſalamander* the conformation is preciſely the ſame. The oſſa ilii are narrow, and almoſt cylindrical; and the oſſa pubis completely united with the iſchium, forms only a large bony plate without any hole.

ARTICLE II.

Of the Muſcles of the Pelvis.

A. *In Man.*

THE muſcles of the pelvis in man are few in number.

1. THE

1. THE QUADRATUS LUMBORUM *or* ILEO-COSTALIS.

This muſcle occupies the ſpace between the os ilium, from which it ariſes, and the laſt falſe rib which receives one of its inſertions: the others go to the tranſverſe proceſſes of the four firſt lumbar vertebræ. It acts more manifeſtly on the ſpine than on the pelvis.

2. THE PSOAS PARVUS, *or* PRÆLUMBO-PUBALIS,

Ariſes from the body of the laſt dorſal vertebra, and forms a thin flat tendon, which is inſerted into the ileo-pectineal eminence. It raiſes the pelvis towards the ſpine.

B. *In other Mammiferous Animals.*

Theſe muſcles have the ſame origin in almoſt all *quadrupeds*; they differ only in their proportions, which depend upon the number of the lumbar vertebræ. The *pſoas parvus* is wanting in the *rat.*

Bats have no *quadratus lumborum;* but their *pſoas parvus* is very ſtrong, and its aponeuroſis is very broad.

C. *In Birds.*

Birds have neither the *pſoas parvus,* nor the *quadratus lumborum.*

D. *In Reptiles.*

In the *tortoiſe* the muſcle analogous to the *quadratus lumborum* expands under the back ſhell between the laſt anterior ribs; it ariſes from the ilium towards the articulation of that bone with the os ſacrum, which in this animal is moveable.

This mobility of the pelvis is aſſiſted by a muſcle analogous to the *rectus abdominis*, which, as we have obſerved, inſtead of extending under the belly, is attached under the poſterior extremity of the breaſt plate, by two fleſhy portions, one anterior, the other poſterior, which are both inſerted in the anterior margin of the external branch of the pubis.

There is no *pſoas parvus* in *frogs*. The *quadratus lumborum* extends from the long tranſverſe proceſs of the third vertebra, to the origin of the long bone of the pelvis, which is analogous to the ilium. It is inſerted in this bone, which it raiſes towards the head; their ilium being moveable, like that of the tortoiſe.

N. B. We ſhall poſtpone our obſervations on the poſterior extremity, or ventral fin of fiſhes, until the end of this Lecture.

Article III.

Of the Thigh Bone.

The cotyloid cavity is ſemi-ſpherical. In its brim, oppoſite to the oval or ſub-pubic foramen, there is a notch which correſponds to the axis of the thigh bone when man is erect. The direction of the cavity is from the ſide downward and a little forward. The brim of this articular cavity is furniſhed with a very ſtrong ligament, which greatly augments its extent in the recent ſtate.

In other mammiferous animals the notch of the cotyloid cavity correſponds alſo to the foramen ovale; but the difference of poſition of the plane of that hole renders it neceſſary that the bone of the thigh ſhould be perpendicular to the ſpine, or form an acute angle with it anteriorly, in order that its axis may correſpond with the notch. This indeed is the poſition of the femur when quadrupeds reſt tranquilly on their four feet. The angle which the femur forms with the vertebral column is almoſt a right angle in the Carnivora: in the hoofed animals it is acute. The direction of the cavity in mammiferous animals is alſo conformable to the poſition of the femur. It is ſuch that when the ſpine is horizontal, it is directed outward and downward; but in the animals which ſwim much, as the *otter* and the *beaver*, it proceeds directly from the ſide, and even inclines a little upward.

A. *In Man.*

The femur itſelf is a ſimple bone, almoſt cylindrical, and ſlightly arched upon the inner and back part. Its ſuperior extremity is enlarged, and has two proceſſes: one almoſt in the direction of the axis, called the *great trochanter;* and another, which is directed inwardly, and forms an obtuſe angle with the axis inferiorly: the latter is called the neck. It is terminated by a ſpherical tuberoſity, which moves in every direction in the cotyloid cavity, and is called the head of the os femoris. This articulation is ſupported by a capſular ligament which ariſes from the whole circumference of the cavity, and is inſerted around the neck and the head of the femur. There is beſides a round ligament within the articulation, which ariſes from the ſmall foſſa of the cotyloid cavity, and is inſerted in a depreſſion in the middle part of the head of the bone. Under the neck, and ſomewhat anteriorly, there is ſituated a ſmall tubercle called the *little trochanter* or *trocantin*, and along the poſterior ſurface there is extended an elevated line called *linea aſpera* of the femur.

B. *In other Mammiferous Animals.*

In all claſſes of animals the thigh has only one bone: Its form varies little, but its proportion with reſpect to the other parts of the abdominal member, depends, in general, on that of the metatarſus.

In the Ruminantia and the Solipeda, for example, it is ſo ſhort that it ſeems to be concealed within the fleſh of the abdomen: on this account, the part which really correſponds to the leg is, in thoſe animals, vulgarly called the thigh.

The os femoris is not incurvated in the mammiferous quadrupeds; its neck is alſo ſhorter than in man, and more perpendicular to the axis. Thus the head is directed entirely inward, and the great trochanter riſes above it.

In *monkies* the os femoris is perfectly cylindrical, and has hardly any linea aſpera.

In the *tapir* the middle part of the thigh-bone is very flat; it has, on its external edge, a projecting ridge, which terminates in a proceſs reſembling an hook.

This conformation is ſtill more ſtriking in the *rhinoceros*. The great trochanter and this unciform proceſs are much prolonged, and cloſe again in ſuch a manner as to leave a hole between them and the body of the bone.

The unciform proceſs is alſo found in the *horſe*, the *armadillo*, and the *beaver*.

In the *ſeal* the thigh is ſo ſhort that the two articular extremities make up more than half its length.

C. *In Birds.*

The thigh-bone in birds has only one trochanter. It is always very ſhort in proportion to the leg. Its form is cylindrical. It is almoſt always ſtraight, and rarely incurvated, as in the *cormorant*, the *diver*, and the *little grebe (colymbus minor.)*

In the *oſtrich* the thigh-bone is very thick in proportion to the humerus, its diameter being almoſt four times as great. Its two extremities are larger than its middle part, which is nearly triangular.

D. *In Reptiles.*

The thigh-bone of oviparous quadrupeds reſembles that of other animals; it has, however, a double curvature, more or leſs evident. In front it preſents a convexity towards the tibial extremity, and a concavity near the pelvis. In the *tortoiſe* the trochanters are well defined, but they are not to be found in the *lizards* and *frogs*.

The figure of the femur is in general round, except in the *Surinam toad*, in which it is very flat.

Article IV.

Of the Muſcles of the Thigh.

I. Muscles of the Great Trochanter.

The muſcles which extend to the great trochanter of the os femoris, roll it upon its axis in the cotyloid cavity, either by bringing the toe from within outward, or by producing the oppoſite motion. They may alſo extend the thigh a little in the direction of the ſpine, or, what amounts to the ſame thing, make it diverge from the other thigh:

A. *In Man.*

The layer next to the bone is compoſed of the following muſcles:

1. THE GLUTÆUS MINIMUS, *or* ILIO-TROCHANTERUS,

Which ariſes from the anterior and inferior part of the os ilium, and is inſerted, by a thin tendon, into the anterior and ſuperior ſide of the great trochanter. It raiſes the thigh directly up towards the ſide.

2. THE PYRIFORMIS, *or* SACRO-TROCHANTERUS.

This muſcle proceeds from the interior of the pelvis, where it ariſes from the ſuperior part of the lateral edge of the os ſacrum, and is inſerted, by a ſlender tendon, into the top of the great trochanter, behind the preceding. It turns the thigh on its axis from within outward.

3. THE GEMINI, *or* ISCHII-TROCHANTERI.

Theſe ariſe from the poſterior edge of the iſchium, and are inſerted into the top of the great trochanter, behind the preceding muſcle, to the tendon of which they in ſome degree adhere. They likewiſe produce the ſame effect.

4. THE OBTURATOR INTERNUS, *or* SUB-PUBO-TROCHANTERUS.

This muſcle ariſes from the internal part of the border and membrane of the foramen ovale, and is inſerted into the great trochanter by a ſlender tendon that turns round the poſterior edge of the iſchium, between the gemini, which form a ſort of ſheath for it. Its action is ſimilar to theirs, but much more powerful, as it is aided by the pulley over which it ſlides.

5. THE QUADRATUS FEMORIS, *or* ISCHIO-TROCHANTERUS,

Ariſes from the tuberoſity of the os iſchium, and is inſerted into the poſterior edge of the great trochanter, under the preceding. It is a rotator of the thigh, which it moves from within outwardly.

Over the glutæus minimus and pyriformis we find

6. THE GLUTÆUS MEDIUS, *or* ILIO-TROCHANTERUS.

It ariſes from all the large circumference of the os ilium, and, collecting its fibres, is inſerted into the great trochanter. It raiſes the thigh, carrying it, at the ſame time, outwards, in the ſame manner as the glutæus minimus.

Laſtly,

7. THE GLUTÆUS MAXIMUS, *or* SACRO FEMORALIS.

This covers part of the preceding, and all the ſmaller muſcles. It ariſes from the poſterior edge of the os ilium and the ſacrum, and is inſerted into the poſterior part of the os femoris, below the great trochanter. It is a very ſtrong muſcle, which erects the trunk upon the extremities, carries the thigh backwards upon the trunk, and is one of thoſe that act moſt powerfully in the motions of the abdominal member.

B. *In other Mammiferous Animals.*

In the *monkey* the elongation of the os ilium renders the *glutæus medius* and *minimus* larger;

but the muſcle analogous to the *glutæus maximus* is the leaſt of the three.

The *quadratus femoris* is proportional to the greatneſs of the tuberoſity of the iſchium.

Bats have a *glutæus minimus*, which deſcends almoſt perpendicularly from the ilium to the thigh. They have neither *pyriformis*, *gemini*, *obturator internus*, nor *quadratus femoris*.

In the Carnivora and Rodentia the ſame proportional minuteneſs of the *glutæus maximus* is found as in the *monkies*.

The *glutæus medius* and *maximus* exhibit nothing peculiar.

In the *horſe*, the muſcle analogous to the *glutæus maximus*, (but called by Bourgelat *glutæus minimus*,) is, in a great meaſure, aponeurotic. It has a long ſlender belly in addition to the ordinary one, which ariſes from the ſummit of the os ilium.

The *glutæus medius*, which is very conſiderable, ariſes likewiſe from the ſacrum, and from all the membrane between that bone, and the ilium and iſchium. This muſcle is the principal agent in kicking; it is inſerted into that particular proceſs which may be conſidered as a third trochanter.

The other little muſcles of the great trochanter are the ſame in quadrupeds as in man.

C. *In Birds.*

The three *glutæi* have the ſame proportions as in quadrupeds.

That which is analogous to the *maximus* is the muſcle called *pyramidalis* by *Vicq D'Azyr*. The *minimus*, which ariſes from the inferior edge of the os ilium, is his *iliacus*.

The *pyriformis* and the *gemini* are wanting. That analogous to the *quadratus femoris* is very large.

The *obturator internus*, inſtead of paſſing through the hole correſponding to the iſchiatic notch, paſſes over that which is analogous to the foramen ovale.

In ſome birds there is even a tranſverſe piece of bone which forms a particular foramen.

II. MUSCLES OF THE LITTLE TROCHANTER AND THE INSIDE OF THE THIGH.

The muſcles which go to the little trochanter and the internal ſurface of the thigh, bend it, or bring it nearer to the other. They are,

A. *In Man,*

1. THE PSOAS, *or* PRÆLUMBO-TROCHANTINUS.

This muſcle ariſes from the ſides of the lumbar and laſt dorſal vertebræ, and is inſerted, by a ſmall tendon, into the leſſer trochanter. It raiſes the thigh, and brings it directly forward.

2. THE ILIACUS, *or* ILIO-TROCHANTINUS.

This ariſes from the internal ſurface of the os ilium, and has its inſertion in the leſſer trochanter, in common with the pſoas. It produces the ſame effect as that muſcle.

3. THE PECTINEUS, *or* PUBO-FEMORALIS,

Ariſes from the ſuperior margin of the os pubis, and is inſerted by a ſlender tendon below the little trochanter. It aſſiſts a little the action of the preceding muſcles.

4. THE THREE ADDUCTORS, SUB-PUBO, SUB-PUBI, ISCHII-FEMORALES, *or* TRICEPS ADDUCTOR,

Ariſe thus: namely, the firſt from the ſymphyſis pubis, the ſecond from its deſcending branch, and the third from the tuberoſity of the iſchium. They all extend to the linea aſpera of the thigh, where the ſecond is inſerted between the two others, but ſomewhat above them. They bring the thighs inward, or towards each other.

5. THE OBTURATOR EXTERNUS, *or* SUB-PUBO TROCHANTERUS EXTERNUS.

This covers the foramen ovale, and is inſerted behind and into the cavity of the great trochanter; it rolls the thigh outwards.

B. *In*

B. *In other Mammiferous Animals.*

In *quadrupeds* in general the *pſoas* and *iliacus* are much longer than in man.

The *pectineus* of the *dog* is fleſhy, and its lower tendon extends to the bottom of the os femoris; but this is not the caſe in other quadrupeds.

Bats have neither *pſoas* nor *iliacus*. Their *pectineus* is long and ſlender, as well as the *obturator externus*. They have but one *adductor femoris*, which ariſes from the ſymphyſis pubis, and is inſerted into the upper part of the thigh, about one-third from the head.

The Cetacea have not even a rudiment of the muſcles of the thigh.

C. *In Birds.*

Birds have neither *pſoas iliacus*, nor *obturator externus*. The muſcle which *Vicq D'Azyr* has named *iliacus*, is no other than the *glutæus minimus*. They have two adductors in the common ſituation.

In the part occupied by the pectineus of quadrupeds, there is a little ſlender muſcle which is prolonged to the knee. Its tendon paſſes obliquely over, and then under the leg, to join the *flexor perforatus* of the ſecond and fifth toes. We ſhall ſpeak of it preſently.

D. *In Reptiles.*

In the *frog* there is only one *glutæus*, which is in the place of the *medius*. It ariſes from the elongation which ſupplies the place of the os ilium, and is inſerted below the head of the femur.

The *pyriformis* comes ſtraight from the point of the coccyx, and is inſerted about one-third from the top of the os femoris.

The *gemini* and the *obturator internus* are wanting.

The *quadratus femoris* is long. It ariſes from the poſterior ſymphyſis of the iſchium, and is inſerted into the inner ſide of the thigh-bone, about one-third from the head.

They have neither the *pſoas magnus* nor *parvus*.

The *iliacus* is proportionally elongated.

The *pectineus* deſcends to the middle of the thigh-bone.

The *three adductors* have the ſame origins and inſertions as in man.

The *obturator externus* is to be found, though there is no foramen ovale. It ariſes from the ſymphyſis pubis, and its fibres are attached to the capſular ligament.

In the *tortoiſe* the muſcles of the thigh produce motions proper to ſwimming; that is to ſay, the abduction, adduction, depreſſion, and elevation of the thigh.

The muſcle analogous to the *adductor longus* ariſes from the ſymphyſis pubis, and is inſerted into the internal part of the thigh-bone, about one-third from its tibial extremity.

Another muſcle, which cannot eaſily be compared to any in man, ariſes from the interior of the ſacrum, and is inſerted into the little trochanter. It is another *adductor femoris*.

A muſcle compoſed of different radiated faſciculi, ariſes from the broad inferior ſurface of the os pubis, and forms a thick tendon, inſerted into the little trochanter. It occupies the place, and anſwers the purpoſes of the *pſoas* and *iliacus*.

That which is analogous to the *adductor brevis* ariſes from the ſymphyſis of the bones of the iſchium and the interoſſeous ligament of the pubis. It is inſerted into the os femoris below the little trochanter.

The muſcle anſwering to the *glutæus maximus* ariſes from the ſpine oppoſite to the laſt rib, and is inſerted into the thigh-bone, below the great trochanter.

The muſcles analogous to the *glutæus medius* and *minimus* can hardly be diſtinguiſhed from each other. They riſe from the internal ſurface of the os pubis, and are inſerted into the great trochanter.

That which reſembles the *obturator internus* ariſes from the internal ſurface of the ilium and the ſuperior edge of the cotyloid cavity, and is inſerted into the great trochanter.

ARTICLE V.

Of the Bones of the Leg.

THE human thigh-bone becomes thicker towards the extremity next the tibia. It there forms two eminences, which riſe from the axis of the bone, and which are named the *internal* and *external condyles of the os femoris.* Each is furniſhed with an articular ſurface like the ſegment of a wheel, which correſponds to another in the tibia, one of the bones of the leg. They are likewiſe as it were ſeparated before by a large notch or articular depreſſion, in which the *rotula,* a little bone ſituated upon the knee, moves. Behind the condyles there is a hollow which is called the *foſſa poplitea.*

The two condyles of the os femoris are unequal. When that bone is placed in an erect poſition by reſting the condyles upon a horizontal plane, its axis leans towards the external ſide. This obſervation is worthy of notice; for, in quadrupeds, the poſition of the condyles is horizontal, and the axis of both thigh-bones parallel in a ſtate of reſt, while the ſituation of the condyles in birds is ſo oblique, that the coxal extremities and the whole axis of the bones bend towards the central line, or take a direction oppoſite to the human.

A. *In Man.*

The leg is compoſed of two bones; a larger, called *tibia*; and a ſmaller, attached to the exterior ſide of it, called *fibula*, or *perone*.

The tibia is articulated with the thigh-bone by a broad ſurface, in which we find two ſlight depreſſions that correſpond with the condyles of the thigh. The femoral extremity of this bone is much larger than the middle part, and has three longitudinal ridges, which continue almoſt three-fourths of the length of the bone. The anterior one is called the *ſpine of the tibia*, and is flattened towards the top into a large rough triangular ſurface. That of the outſide is next the fibula, and ſerves for the inſertion of a membrane, occupying the ſpace between theſe two bones, and which is called the *interoſſeous ligament*. The third ridge is internal, and ſomewhat poſterior.

The ſuperior extremity of the fibula is connected to the tibia beneath a projection at its external and poſterior angle. And as the bodies of both become ſmaller, there is a ſpace between them, larger towards the top, but contracted below. The fibula has alſo three longitudinal edges.

Theſe two bones are incapable of that rotatory motion on each other which thoſe of the fore-arm poſſeſs.

The fibula is joined to the tibia by three ſorts of ligaments. The one a capſule, which binds the articular ſurface of the ſuperior extremity to the head of the tibia. The ſecond is a ligamentous membrane, which fills the whole ſpace comprized between the two bones, and unites them by thoſe ridges which are next each other. The third kind is produced by fibres which ariſe obliquely from the tibia, and extend to the malleolus externus both before and behind.

Over the articulation of the os femoris with the tibia, and between the condyles of the former, there is placed a little bone, almoſt circular, but rather pointed towards the lower part. It is convex, and rough before, and has, on its poſterior part, two articular ſurfaces, which correſpond with thoſe of the thigh-bone. It is ſuſpended, in this place, by ligaments and muſcles, and prevents the extenſion of the tibia beyond a right line. It is called *rotula*, or *patella*, and is the bone that forms the angle of the knee.

The articulation of the four bones which form the knee is ſtrengthened by a great number of ligaments. There is, in the firſt place, a capſule, which riſes from the circumference of the condyles of the femur, and is inſerted into the edges of the rotula and tibia. We next obſerve ſome faſciculi of ligamentous fibres which paſs in different directions. Some riſe from the external condyle of the thigh, and are inſerted into the inſide of the head of the tibia. One ligament proceeds from the internal condyle, and is inſerted into the external ſide of the tibia, and even into the fibula. In the joint itſelf are ſituated two ligaments, placed croſſways one over the other, and called the *crucial ligaments*; they proceed from the poſterior part of the condyles of the thigh, and are inſerted into the middle of the elevated line that divides the two articular depreſſions of the head of the tibia.

Two *interarticular ligaments* of a ſemilunar form, are alſo interpoſed between the tibia and os femoris: they are retained in their ſituation by little bundles of ligamentous fibres, which riſe from different points of the capſule. Finally, the rotula has a peculiar and very ſtrong ligament which proceeds from its pointed end to the ſpine of the tibia. It ſeems to be of a tendinous nature, and produced by the termination of the tendon of the exterior extensor muſcles, in the ſubſtance of which this ſuper-articular bone is encloſed.

B. *In other Mammiferous Animals.*

The bones of the leg are generally the ſame in the inferior mammalia as in man.

In *monkies*, the anterior ſpine of the tibia is not very diſtinct.

In the *bat*, the fibula is extremely ſlender; and as the thighs are turned backward, the legs muſt have the fibulæ facing each other.

In the *mole*, the fibula is oſſified to the tibia, about one-third of the lower part of its length.

The tibia of the *bear* is ſomewhat curved forward: the tuberoſity of its anterior edge is very prominent, and its articular ſurfaces very far back.

The *dog* has the fibula attached to the whole length of the tibia poſteriorly.

The fibula of the *opoſſum* is large and much bent, which ſeparates it conſiderably from the tibia.

The *longtailed manis*, the *armadillo*, and the *ſloth*, likewiſe have the fibula pretty large, curved, and ſeparate from the tibia.

The Rodentia have the fibula entirely behind. *Rats* have it oſſified to the tibia about one-third from its lower end. In the upper part it forms a large vacant triangular ſpace.

In the *elephant*, the *rhinoceros*, and the *hog*, the fibula is flat and anchyloſed in its whole length to the tibia.

In the Ruminantia it does not exiſt. This bone ſeems ſupplied by a ſmall oſſeous ſubſtance placed on the external edge of the aſtragalus below the tibia, and forming the malleolus externus.

Finally, in the *horſe*, the fibula is only a rudiment anchyloſed by age to the upper part of the tibia.

C. *In Birds.*

Birds have the lower part of the thigh-bone nearly diſpoſed like that of mankind.

The leg is likewiſe formed by the tibia, the fibula, and the rotula.

The tibia differs but little from that of the mammalia, except in its lower extremity, as we ſhall ſee in treating of the tarſus. The anterior and ſuperior tuberoſity has generally two ridges.

The fibula is always oſſified to the tibia, and never reaches its lower extremity.

The *diver* and the *little grebe* have the tibia prolonged in the front of its articulation with the thigh-bone: this prominence has three ſurfaces; it ſerves for a rotula, and furniſhes inſertions for the muſcles.

In the *manchot*, this prolongation of the tibia has already been remarked, but the projection which it makes before the knee is ſcarcely the length of a centimetre.

D. *In Reptiles.*

Oviparous quadrupeds have the tibia and fibula diſtinct and ſeparated from each other throughout their whole length. Theſe two bones are nearly of the ſame magnitude in the *tortoiſes* and *lizards*.

The *frog* has but one bone, but a furrow ſeems to indicate the union of the tibia and fibula.

In theſe animals the tibia and fibula are, for the moſt part, directly articulated to the thigh-bone.

ARTICLE VI.

Of the Muſcles of the Leg.

A. *In Man.*

THE extenſors of the leg all terminate in one common tendon, which is inſerted into the rotula, and thence continued to the anterior tuberoſity of the tibia. Theſe muſcles are four in number: the three firſt of which, the *vaſtus internus*, the *vaſtus externus*, and the *cruralis*, are by many regarded as one ſingle muſcle, which they nam [illegible]

TRICEPS-FEMORIS, *or* TRIFEMORO-ROTULARIS.

The *cruralis* ariſes from the whole anterior ſurface of the thigh-bone, the *vaſtus externus* from the region of the great, and the *internus* from that of the little trochanter.

The fourth extenſor is the

RECTUS ANTERIOR, *or* ILIO-ROTULARIS,

Which ariſes from the ſpine of the os ilium, and extends along the whole anterior part of the thigh.

The flexors of the leg are all inſerted into the internal ſide of the tibia, except one, which is inſerted into the fibula. This is the

BICEPS, *or* ISCHIO-PERONEUS,

Which receives one part of its fibres from the tuberoſity of the os iſchium, and the other from the middle of the linea aſpera of the os femoris. Theſe two unite in one ſmall tendon, which is inſerted into the head of the fibula.

From the ſame tuberoſity of the iſchium, ariſe two other muſcles ſituated behind the biceps, viz.

THE SEMIMEMBRANOSUS, *or* ISCHIO-SUBTIBIALIS, *and* THE SEMITENDINOSUS, *or* ISCHIO-PRETIBIALIS.

The firſt is inſerted into the tibia by a flat thin tendon, and the other a little lower down, by a round and ſlender tendon. Under the ſemitendinoſus is inſerted

THE SARTORIUS, *or* ILIO-PRETIBIALIS,

Which ariſes from the ſpine of the os ilium, and paſſes ſpirally over the fore part to the inſide of the thigh, ſomewhat lower than the others.

THE GRACILIS, RECTUS INTERNUS, *or* PUBIO-PRETIBIALIS.

This muſcle ariſes from the lower edge of the ſymphyſis pubis, and deſcends ſtraight along the inner ſide of the thigh.

Laſtly:—

THE POPLITEUS, *or* POPLITO-TIBIALIS.

This is a little muſcle ſituated behind the knee: it extends obliquely from the external condyle of the thigh to the internal part of the head of the tibia.

Theſe muſcles, with the adductors of the femur, &c. form altogether the long and round maſs which ſurrounds that bone, and is called the thigh. They are all incloſed in an aponeurotic ſheath, called the *faſcia lata*, which is provided with a particular muſcle, ILIO-FASCIALIS, the fibres of which are entirely covered by the aponeuroſis.

B. *In other Mammiferous Animals.*

The thigh of the *monkey* is leſs round than that of man; their muſcles, however, differ but little from his, except the *biceps*.

In *quadrupeds, in general*, the thigh being preſſed againſt the flank, the fleſhy maſs becomes more compreſſed. The *ſartorius* and *gracilis* form the anterior edge of the thigh in the Carnivora and Rodentia.

In the *horſe* the *ſartorius* becomes more conſpicuous, and takes the name of ADDUCTOR LONGUS, in oppoſition to the *gracilis internus*, which is called ADDUCTOR BREVIS.

In *all quadrupeds*, and even in the *monkey*, the muſcle analogous to the *biceps* in man has only a ſingle head riſing from the os iſchium: it covers a large portion of the external ſurface of the thigh, and not only tranſmits fibres to the fibula, but likewiſe to the whole length of the *faſcia lata*, ſo that it thus performs the office of an extenſor of the thigh. This is the muſcle which Bourgelat has named VASTUS LONGUS in the *dog* and the *horſe*.

The *gracilis internus* is large in all quadrupeds, and particularly in thoſe that have the thigh ſhort. In the *hoofed animals*, therefore, it forms a very conſiderable muſcle. Bourgelat calls it ADDUCTOR BREVIS, and gives the name of GRACILIS INTERNUS to the muſcle which is analogous to the *ſemitendinoſus*.

The *ſemimembranoſus* and *ſemitendinoſus* are found in all quadrupeds as well as in man; but they are both inſerted into the tibia by a broad aponeuroſis. It muſt alſo be remarked that their point of inſertion is lower than that of man. This conformation keeps the leg perpetually in a ſtate of ſemiflexion, and is one of the cauſes which prevent quadrupeds from walking upright. In *monkies* theſe muſcles are alſo inſerted very low in the tibia.

The extenſors, that is to ſay the *rectus anterior* and the *triceps*, are found in quadrupeds as well as in man, with ſome ſmall difference in their proportions.

The *bats*, in which the poſterior extremities ſeem turned in ſuch a manner that they bend backward, have only two muſcles proper to the leg; one, which ſupplies the place of the *ſartorius*, the *gracilis*, the *ſemitendinoſus*, and the *ſemimembranoſus*,

membranoſus, riſes by two fleſhy bellies ſeparate from each other, between which the *adductor femoris* paſſes. The firſt of theſe portions comes from the anterior part of the ilium, and the other from the pubis and the iſchium. They form one common tendon, which goes to what is commonly the poſterior, but which is here the anterior part of the leg, and is inſerted into the tibia below its articulation with the os femoris. This is the flexor of the leg.

The extenſor of the leg riſes by a ſingle fleſhy belly, from the ſuperior extremity of the os femoris. Its tendon is ſlender, and is inſerted into the poſterior extremity of the leg, which, we repeat, is here turned round.

C. *In Birds.*

The extenſors of the leg in birds are nearly the ſame as thoſe of quadrupeds; they have three flexors.

The moſt external ſeems analogous to the *biceps* in man. It riſes from the whole ſpine of the iſchium, and ſends off a round tendon, which paſſes through a ligamentous pulley under the joint of the knee, and is inſerted into the fibula.

The internal is analogous to the *ſemimembranoſus*. It ariſes from the extremity of the iſchium, and is inſerted in the inner ſide of the head of the tibia.

The third, which is intermediate, is wanting in ſeveral birds, particularly in *thoſe of prey*. It likewiſe ariſes from the ſpine of the iſchium, and its tendon receives a ſecond bundle of fleſhy fibres from the bottom of the thigh. It paſſes between the gaſtrocnemii, and is inſerted into the poſterior ſurface of the tibia.

The *ſartorius* forms the anterior edge of the thigh, but it inclines towards the inner ſide.

D. *In Reptiles.*

The *frog* has the thighs round, like thoſe of a man, and the muſcles of the leg very conſpicuous.

The *triceps femoris* is formed only of two very diſtinct portions. The *vaſtus externus* and the *cruralis* are manifeſtly but one.

There is no *rectus anterior*.

The *biceps flexor cruris* has only one belly. It ariſes from the poſterior and interior part of the ilium, and is inſerted into the exterior and anterior ſurface of the tibia, for there is no fibula.

The *ſemimembranoſus* is like the human; but the *ſemitendinoſus* is compoſed of two bellies, one of which riſes from the ſymphyſis pubis, and the other from that of the iſchium.

The *ſartorius* is ſituated exactly in the front of the thigh, without any obliquity.

There is nothing remarkable in the *gracilis*.

There is no diſtinct *popliteus*.

Some differences occur in the muſcles of the leg of the *tortoiſe.* Theſe have a relation to the faculty of ſwimming, for which its extremities are fitted.

The muſcle which takes the place of the *ſemimembranoſus* ariſes from the interoſſeous ligament of the pelvis, and proceeds to form a ſtrong aponeuroſis at the inferior part of the leg.

That which is correſponding to the *ſemitendinoſus* ariſes also from the interoſſeous ligament: it paſſes under the ham, and is inſerted into the tibia, which it bends.

That which is analogous to the *ſartorius* ariſes from the os pubis near the interoſſeous ligament, and paſſes over the knee, to be inſerted into the tibia, which it extends.

A muſcle, compoſed of two fleſhy portions, both of which ariſe from the lateral parts of the ſacrum, is inſerted below the head of the tibia, and bends the leg. In its action it much reſembles the *biceps,* from which, however, it differs with reſpect to its attachments.

Another muſcle reſembling the faſcia lata, and very thin in its fleſhy part, ariſes from the ſides of the coccyx. It paſſes under the ſkin of the fin to its inſertion almoſt oppoſite to the heel. It bends the leg upon the thigh, and extends the foot upon the leg.

The muſcle analogous to the *biceps* ariſes from the ſacrum and ilium. It goes to the external ſurface of the leg, where it is inſerted into the fibula.

The *extenſor* of the leg preſents nothing particular.

The muſcle analogous to the rectus anterior ariſes from the internal ſurface of the pubis, and joins the common tendons of the extenſors.

Article VII.

Of the Bones of the Ancle or Tarſus, and thoſe of the Metatarſus.

A. *In Man.*

The tibia, which is nearly triangular at the top and the middle, becomes round towards the bottom, where it is ſenſibly enlarged. It is truncated by a flat articular ſurface. There is a ſlight elevation in the middle, paſſing from the front backwards; on the inner ſide there is a deſcending production called the *malleolus internus*.

Upon the external ſide of the inferior extremity of the tibia, there is a depreſſed articular ſurface that receives the fibula, which is here prolonged downward to form the *malleolus externus*, that is longer than the internus.

Under the articular ſurface of the tibia, and between the malleoli, there is a pulley-ſhaped or ſemi-cylindric portion of the *aſtragalus*, the firſt bone of the ancle or *tarſus*.

This bone moves freely by ginglymus, giving to the foot a motion like a balance; but as the articulation is lax, it has alſo a confined motion ſideways.

The aſtragalus, beſides its articular part, has two ſhort and thick proceſſes, one deſcending anteriorly, and turning ſomewhat inward; the other poſteriorly, and outward. The firſt receives the *os ſcaphoides* upon its digital extremity, and is joined by an articular portion of its inferior ſurface to a particular proceſs of the *calcaneum*. The other proceſs of the aſtragalus extends to the body of the calcaneum.

This ſecond bone of the tarſus has, beſides the proceſs on its internal ſurface which ſupports the aſtragalus, an anterior production directed ſomewhat outward, and parallel to the ſide of that of the aſtragalus: it is at the ſame time lower than the latter. The other is turned backward, and terminates in a large tuberoſity, which projects downward, and forms the heel.

The anterior proceſs of the calcaneum, or os calcis, ſupports the *os cuboides*, to which the two metatarſal bones of the two laſt toes are applied. Thoſe of the three firſt are ſupported by the three *oſſa cuneiformia*, which are placed in front of the os ſcaphoides.

Several ligaments ſtrengthen the articulation of the bones of the leg with thoſe of the ancle. Some extend from the malleolus externus, or the tarſal extremity of the fibula, to the aſtragalus and os calcis: one riſes from the malleolus internus or tibialis, and is inſerted into the aſtragalus, and the circumference of the os ſcaphoides; its figure is triangular. Laſtly, a capſular ligament unites the articular cavity of the tibia to the circumference of the articular ſurface or pulley of the aſtragalus.

The metatarſal bones are parallel, nearly of an equal length, and retained by ligaments analogous to thoſe of the metacarpus.

B. *In other Mammiferous Animals.*

Quadrupeds with toes have almoſt all the bones of the tarſus nearly reſembling thoſe of man. The following are the principal differences:

In the *monkies* the articular ſurface of the aſtragalus, oppoſite to the fibula, is almoſt vertical; that next to the malleolus tibialis is, on the contrary, very oblique, and the anterior production of that bone is turned more inward. It hence follows that the foot reſts more on its external edge than on the ſole.

The os calcis has not the large tuberoſity which forms the heel at its poſterior extremity: on the contrary, it is turned upward, except in the *Batavian pongo*, in which this bone is ſimilar to that of man.

The firſt os cuneiforme is ſhorter than the human, and has an evident groove for the muſcles of the great toe.

The metatarſal bone of the great toe is ſhorter by one-half than the others, and can be eaſily held aſunder from them.

Amongſt the *lemurs*, the *tarſier* and *galago* have the calcaneum and os ſcaphoides exceſſively long, which produces a diſproportion in the whole poſterior extremity, and gives to the foot of theſe animals the appearance of a hand and fore-arm.

The Pedimana, in which the fibula is equal to the tibia at the bottom, have the aſtragalus very ſmall, and articulated almoſt exactly between them. The os calcis is ſhort, and the firſt cuneiforme is very large, and of a ſemilunar ſhape.

The *opoſſum* has a little ſupernumerary bone on the edge of the firſt os cuneiforme.

In the Carnivora the middle projection of the lower ſurface of the tibia is ſtronger, and the ginglymus more complete than in man; but the lateral movements are more obſcure.

The firſt cuneiform bone is leſs in proportion to the others.

The heel is longer: it terminates quite ſtraight in thoſe that tread only upon the toes: but it has a ſmall tubercle in thoſe that walk entirely on the ſole.

Thoſe that have only four toes have the firſt os cuneiforme ſmaller.

In the common *bat* the os calcis is of a conſiderable length. It is a ſtyloid bone, concealed in the thickeſt part of the membranes of the wing which it ſupports; but in the *ternate bat* the tuberoſity of the os calcis turns under the foot, being curved like that of the cuneiforme bone of the carpus in man.

With reſpect to the Plantigrada, the *mole* is particularly remarkable in having its tarſus articulated only to the tibia, to which the fibula is completely oſſified at its lower parts.

The Rodentia have the os calcis much prolonged poſteriorly.

The following facts in thoſe that have five perfect toes are remarkable:

In the *beaver* the os ſcaphoides is divided into two parts; one ſituated in front of the aſtragalus, and ſupporting the ſecond and third oſſa cuneiformia; the other at the inner ſide of the aſtragalus, ſuſtaining the cuneiform bone of the great toe, and a flat ſupernumerary bone placed along the inner edge of the tarſus.

The ſame ſtructure is obſervable in the *marmotte*.

The *porcupine* and the *paca* have the ſcaphoides divided, but the ſupernumerary bone is not found in theſe animals.

The *ſquirrel* has this inner portion of the ſcaphoides very ſmall; it does not ſupport the cuneiform bone belonging to the great toe.

In all, the ſcaphoides forms a tubercle under the ſole; that of the *paca* is elongated.

Among thoſe that have four toes only, the *jerboa of the Cape*, which is remarkable for a long foot, has the inferior tubercle of the ſcaphoides elongated and very prominent; upon the internal edge of the tarſus are ſome long flat bones, which are probably the rudiments of the great toe.

There is nothing ſimilar in the *rabbit* and *hare*, though theſe animals reſemble the *jerboa* in the tubercle of the ſcaphoides.

In the *cavy* and *agouti*, which have only three toes, we find this internal part of the ſcaphoides ſupporting a ſingle bone that anſwers to the firſt os cuneiforme, and the rudiment of the great toe externally. Upon the cuboides there is a ſmall bone which may be regarded as a rudiment of the little toe.

In the Edentata the tarſus of the *three-toed ſloth* is very remarkable, both with reſpect to its articulation and form. It is compoſed of only four bones, viz. the aſtragalus, the os calcis, and two cuneiformia. The aſtragalus is articulated with the fibula, the os calcis and the great cuneiforme. The articulation with the fibula takes place through the means of a conical depreſſion in the ſuperior ſurface of the aſtragalus, and in which is received the head of the bone, the figure of which correſponds in relief with that of the depreſſion of the aſtragalus. Upon the internal lateral part there is an articular convex ſurface which rolls upon the external portion of the tarſal extremity of the tibia. From this mode of articulation it follows, that the foot of the *ſloth* cannot be moved up and down, and that it is only capable of the lateral motions of adduction and abduction: It poſſeſſes therefore the faculty of embracing the trunks of trees, and climbing them; but the action of walking is rendered extremely difficult.

The articular ſurface of the os calcis is a ſimple tubercle received in a depreſſion of the aſtragalus: this alſo aſſiſts the motions we have juſt deſcribed. Its tuberoſity, or the heel, is conſiderably elongated, and forms more than two-thirds of the bone.

The two oſſa cuneiformia preſent nothing particular in their ſtructure. The internal is articulated with the aſtragalus, the external with the os calcis.

The *elephant* has the tarſus and metatarſus very short; theſe parts have nothing ſingular, only that the cuboides turns inwardly quite before the ſcaphoides.

In the *hog* there are, upon the ſcaphoides, the three common cuneiform bones, and one below the firſt, which seems the rudiment of a great toe.

The *tapir* and the *rhinoceros* have only two cuneiformia; and here we muſt remark, that all the animals hitherto mentioned have as many metatarſal bones as toes.

In the Ruminantia, the cuboides and the ſcaphoides are united together, except in the *camel*, which has them diſtinct: at the outward ſide of the pulley of the aſtragalus, there is a bone which ſeems to repreſent the inferior head of the fibula. It is articulated to the top of the os calcis.

There are only two cuneiform bones: in the *giraffe* they are united by oſſification. The two metatarſal bones are always anchyloſed, and form a cannon bone, as in the metacarpus.

In the Solipeda there are two cuneiform bones; and the os ſcaphoides is diſtinct from the cuboides. The little peroneal bone is wanting, as well as the articular ſurface of the os calcis that receives it.

The bone of the metatarſus is alſo ſingle, and called the cannon bone of the hind leg. It has a little oſſeous ſtile on each ſide.

C. *In Birds.*

In birds in general, the fibula terminates by uniting into one with the tibia about its middle. The latter ends in two condyles, like wheels, between which there is a ſort of pulley. The ſingle bone which repreſents the tarſus and metatarſus, has as its head a projection in the middle, and two lateral depreſſions. It conſequently moves in a ginglymus, and bends forward, but it cannot go beyond a right line in the oppoſite direction.

Its proportional length varies: it is extremely long in the birds that ſeek their food on the ſides of rivers, lakes, &c. and which are for that reaſon called *ſtilters* or *waders.*

At the lower end it terminates in three proceſſes, ſhaped like pullies, for the three anterior toes. At the internal ſide it produces a little bone that ſupports the poſterior toe or pollex.

In the *horned owl* the proceſs of the external toe has its flexure directed outward, and ſimply convex, which permits the toe to turn horizontally upon it.

It is turned directly backward in birds that climb.

In thoſe that have no back toe, the little bone is wanting.

The *oſtrich* has only two articular proceſſes, which correſpond to its two toes.

The *manchot* has the three bones which repreſent the tarſus and metatarſus ſeparate from each other at their middle part; but they are united at their extremities, one of which receives the tibia, and the other the three toes.

D. *In Reptiles.*

The aſtragalus is articulated to the tibia, and the os calcis to the fibula in all reptiles.

The tarſus of the *crocodile* has five bones, viz. an aſtragalus, an os calcis, two cuneiformia, anſwering to the two middle metatarſal bones, and one out of the range which anſwers to the external metatarſal bone.

There are four metatarſal bones.

The bone ſituated without the range ſerves to ſupport the little toe in the *mud tortoiſe*. In the *ſea tortoiſe* it is very flat. The os calcis and aſtragalus are very ſmall.

In *frogs* the aſtragalus and the os calcis are very long, and might at firſt ſight be taken for the tibia and fibula, if they did not form the third joint of the poſterior extremity. There are on the fore part, four little cuneiform, five metatarſal bones, and one in the form of a hook, which is very minute. Theſe are ſimilar in the *Surinam* and *common toad*.

ARTICLE VIII.

Of the Muſcles of the Ancle or Tarſus, and of the Metatarſus.

THE muſcles which affect the foot are,

1ſt. Thoſe which act upon the heel by means of the *tendo Achillis*. They extend the foot, and are the principal agents in walking and leaping.

2d. Thoſe which bend it.

3d. Thoſe that lift up either of its ſides.

The *tendo Achillis*, which is inſerted into the head of the os calcis, has three muſcular bellies.

1. THE GASTROCNEMIUS, *or* BI-FEMORO-CALCANEUS.

Theſe muſcles ariſe from the two condyles of the thigh, and compoſe the calf of the leg.

2. THE SOLEUS, *or* TIBIO-CALCANEUS

Is ſituated before the others. In man, where it is of conſiderable magnitude, it riſes from the poſterior ſurface of the upper part of the tibia and fibula.

Theſe muſcles are very large in man, as he has the calf of the leg much greater than any quadruped.

The three muſcles are always to be found, but the *ſoleus* is not ſo large in quadrupeds as in man. It ariſes from the external ſurface of the ſuperior head of the fibula. It is remarkably ſlender in the Ruminantia and Solipeda.

3. THE PLANTARIS, PLANTARIS-GRACILIS, *or* FEMORI-CALCANEUS,

Spreads its tendon, in man, over the outward edge of the tendo Achillis, and has ſcarce any function except raiſing the capſula. It is therefore very ſmall.

In *monkies*, this muſcle is evidently continued along with the plantar faſcia. We ſhall ſee hereafter, that in the other quadrupeds it ſupplies the place of the *flexor perforatus.*

In *birds*, the tendons of the *gaſtrocnemii* remain ſeparate till very near the heel. The *ſoleus* runs inwardly, and is inſerted into a linea aſpera which belongs to the tibia. It is proportionally largr than in quadrupeds.

The flexion of the foot with reſpect to the leg, or of the leg with reſpect to the foot, is performed by

THE TIBIALIS ANTICUS, CRURALIS ANTERIOR, *or* TIBIO-SUPER-TARSEUS,

Which ariſes from the anterior ſurface of the tibia. Its tendon having paſſed through the annular ligament of the leg, runs to the inſide of the foot, where it is inſerted into the firſt cuneiform and the metatarſal bone of the great toe.

In animals which have no great toe, ſuch as the *dog* and the *rabbit*, it is inſerted into the metatarſal bone of the ſecond toe, which with them is the firſt.

It always raiſes in ſome degree the inſide of the foot.

In the Biſulci and Solipeda, it is inſerted into the anterior ſurface of the baſe of the cannon bone.—It is ſimilar in *birds.*

Beſides the action of the tibialis anticus, the inner ſide of the foot is likewiſe raiſed by

THE

THE TIBIALIS POSTICUS, CRURALIS POSTERIOR, *or* TIBIO-SUB-TARSEUS.

This muſcle riſes from the poſterior ſurface of the tibia. Its tendon runs behind the malleolus internus, and is inſerted into the under part of moſt of the bones of the tarſus.

In the *monkey*, its tendon contains a ſeſamoid bone of conſiderable ſize, ſituated under the os ſcaphoides.

In animals that have no great toe, ſuch as the *dog*, the tendon of the tibialis poſticus is inſerted into the edge of the baſe of the metatarſal bone of the firſt toe; and in the *rabbit* it even extends to the ſecond phalanx. It acts, therefore, as an abductor of that toe.

It is entirely wanting in the quadrupeds that that have *cannon bones*, and in *birds*.

The external ſide of the foot is raiſed by the *peroneal muſcles*. Man has three which ariſe from the fibula, and tranſmit their tendons behind the malleolus externus.

THE PERONEUS LONGUS, *or* PERONEO-TARSEUS.

This muſcle adheres to the under part of the os cuboides, croſſes the ſole of the foot, and is inſerted in the metatarſal bone of the great toe, and the firſt os cuneiforme.

THE BREVIS, *or* PERONEI-SUPER-METATARSEUS,

Extends directly to its inſertion in the metatarſal bone of the little toe.

THE MEDIUS, *or* PERONEO-SUPER-METATARSEUS,

Extends to the firſt phalanx of the ſame toe, and ſerves to ſeparate it from the others.

The *peroneus longus*, in the *monkey*, has the peculiar office of bringing the great toe towards the other toes. In animals which have no great toe, it is inſerted into the metatarſal bone of the firſt toe.

In *ruminating* animals it croſſes below the joint of the cannon bone in the ſame manner, and proceeds to its inſertion in the firſt os cuneiforme.

The two other *peronei* in the *monkey*, and all unguiculated animals, reſemble the human, except that, in the *rabbit*, the *medius* ſends off a tendon to the laſt but one of the toes, thereby performing the function of abductor to the two outermoſt toes.

In the Ruminantia this tendon extends to the two toes, but the *brevis* is wanting.

The *horſe* has but one *peroneus*, which unites its tendon to that of the *extenſor digiti*, about the middle of the anterior ſurface of the cannon bone.

In *birds* there is a *peroneus brevis*, which is inſerted into the external baſe of the metatarſal bone; and alſo a muſcle ſeemingly analogous to the *peroneus medius*, (FLEXOR DIGITORUM ACCESSORIUS of *Vicq D'Azyr*.) Its tendon is bifid; one paſſes backward, and is inſerted into the poſterior ſurface of the head of the metatarſus; the other deſcends along the external ſurface of that bone, and is united with that of the *flexor perforatus* of the middle toe.

B. *In Reptiles.*

In the *frog* the *gaſtrocnemius* has only one belly; it has however a ſmall tendon by which it is inſerted into the outward ſide of the head of the tibia. Its tendon runs under the heel, and there ſliding over a a ſeſamoid bone, expands itſelf under the foot to form the plantar faſcia.

There is neither *ſoleus* nor *plantaris*.

The *tibialis anticus* riſes by a ſtrong tendon from the lower part of the os femoris. About the middle of the tibia it divides into two bellies, one internal, the other external. The tendon of the firſt is inſerted into the tibial baſe of the long bone of the tarſus, and that of the ſecond into the ſame bone, a little more outwardly.

An aſſiſtant to this muſcle ariſes from the

middle

middle and anterior part of the tibia, and proceeds to the internal ſide of the baſe of the long bone of the tarſus.

The *tibialis poſticus* reſembles the human, but it is only inſerted into one bone of the tarſus, viz. that which is long, and ſituated at the inner ſide.

There is but one muſcle to which the term *peroneus* can apply. It ariſes by a ſlender tendon from the external condyle of the thigh, and is inſerted into the baſe of the tibia on the outſide, by two tendinous portions, one of which extends to the bone of the tarſus. It extends the leg with reſpect to the thigh, or more properly the thigh with reſpect to the leg.

Beſides theſe muſcles, which extend from the leg to the foot, there is another, which ariſes from the metatarſal extremity of the tibia, at its internal edge, paſſes between the two bellies of the tibialis anticus, and proceeds very obliquely to its inſertion at the digital extremity of the long bone of the tarſus, on its inner ſide.

In the *ſea tortoiſe* the muſcles of the feet are ſupplied by aponeurotic fibres, ſomewhat fleſhy, which ſerve only to ſtrengthen the articulations, and keep the fins properly extended.

ARTICLE IX.

Of the Bones of the Toes, and their Motions.

A. *In Man.*

ALL the toes have three phalanges, except the great toe, which has only two. This, in man, is the longeſt and thickeſt; the reſt gradually diminiſh to the fifth: they are ſhort, and remain parallel to each other; their ligaments are the ſame as thoſe of the fingers.

B. *In other Mammiferous Animals.*

The Quadrumana and Pedimana have the toes longer than the human; but the great toe is ſhorter than the reſt, and its metatarſal bone is capable of being brought cloſe to the others, or ſeparated from them like the thumb.

The *aye-aye*, or *Madagaſcar ſquirrel*, one of the Rodentia, ſeems to poſſeſs the ſame faculty.

In the Carnivora the great toe is always united and parallel to the other toes. The *bears*, *coatis*, *civets*, *badgers*, *racoons*, and *moles*, have it nearly equal to the other toes. The *weaſels* and *ſhrews* have it very little ſhorter.

In the *cats* and *dogs* it is perfectly obliterated.

Among the Rodentia, the *beaver* has the great toe nearly equal to the other toes; the *marmotte*, the *porcupine*, and the *rats*, have it ſhorter. The *paca* has it almoſt obliterated. In the *jerboa of the Cape*, it is completely obliterated, and reduced to a ſingle bone.

The *hares* have not even a rudiment of it.

In the *cavys*, the *agouti*, and the *Guinea pig*, the great and little toe are each reduced to a ſingle bone.

The *jerboa (mus jaculus)*, and the *alactaga (mus ſagitta)*, have their three middle metatarſal bones conſolidated into one cannon bone. The two lateral toes are diſtinct, but ſhorter in the *jerboa*. They are obliterated in the *alactaga*.

Among the Edentata, the *ant-eaters*, the *orycterope (myrmecophaga capenſis)*, the *pangolins* and the *armadillos* have five toes. The great toe is ſhorter than the others in all; and in the *armadillos* the little toe is likewiſe ſhorter.

In the *ſloths* the great and little toe are reduced to a very ſmall ſingle bone. The other bones of the metatarſus are oſſified together at the baſe. There are only two phalanges to the toes; that which ſupports the nail being the largeſt of the two.

In the families of animals which follow, the metatarſal bones deſerve to be conſidered by themſelves. In the *elephant* and other Pachydermata, the tarſal extremity preſents a flat ſurface; and that which is oppoſed to the phalanges is a convex tubercle, which has on the under ſide a projecting longitudinal line in the middle of the bone. In the Solipeda this line is found both above and below. In the Ruminantia, in which the cannon is formed by the two metatarſal bones, a deep line, like the cut of a ſaw, at the union of the two bones, may always be remarked. The conformation is the ſame in the pectoral member.

The *elephant* has five perfect toes.

The *hog* four.

The *tapir* and the *rhinoceros* three.

The Ruminantia have two perfect toes upon a a ſingle metatarſal bone, and two little ones attached to the lower part of the ſame bone, which ſometimes has on each ſide a ſtyloid proceſs.

The Solipeda have one perfect toe, and two imperfect, reduced to a ſingle bone in the form of a ſtyle.

In Birds.

In Birds the number of phalanges generally increaſes from the pollex to the fourth toe, which has always the greateſt number.

Thoſe that have four toes have the number and order of the phalanges as follows:

2, 3, 4, 5.

Among thoſe that have only three toes, the *caſſowary* has them thus diſpoſed:

4, 4, 4.

The reſt have them thus:

3, 4, 5.

The *oſtrich*, which has only two toes, has four phalanges in each.

Thoſe which have four toes have them either all four in front, as the *martins*, or (more generally) three before and one behind; or, like the Scanſores, two before and two behind; as the *parrots*, *toucans*, *barbets*, *cuckows*, *curucuis*, and *woodpeckers*.

Thoſe that have only three toes have them all before. Theſe are the *buſtard*, the *caſſowary*, the *plover*, the *oyſter-catcher*, and the *long-legged plover*, (*charadrius hemantopus*).

Among the Palmipedes, the *albatroſs*, the *petrell*, and the *penguin*, have the pollex obliterated.

D. *In Reptiles.*

The number of the toes varies much in reptiles; as may be ſeen from the following table.

Number of the phalanges of the toes of reptiles, excluſive of the metatarſal bones, beginning at the pollex or internal toe.

Crocodile,	2, 3, 4, 4.
Lizard,	2, 3, 4, 5, 4.
Cameleon,	3, 3, 4, 4, 3.
Salamander,	2, 3, 3, 3.
Sea Tortoiſe,	2, 3, 3, 4, 2.
Mud Tortoiſe,	2, 3, 3, 3, 2.
Frog,	1, 2, 2, 3, 4, 3.

ARTICLE X.

Of the Muſcles of the Toes.

THE toes, like the fingers, have *extenſors*, *flexors*, *abductors*, and *adductors*, either common or proper, long or ſhort.

I. The extenſor muſcles are:

A. *In Man.*

THE EXTENSOR LONGUS DIGITORUM PEDIS, *or* **PERONEO-SUPER-UNGUIALIS.**

THE EXTENSOR LONGUS POLLICIS PEDIS, *or* **PERONEI-SUPER-UNGUIALIS.**

Theſe muſcles are ſituated on the fore part of the leg behind the tibialis anticus. Their tendons paſs below the annular ligament of the leg. The ſecond ſends its tendon to the great toe; the firſt to the other four toes. They extend to the extremities of the toes.

THE EXTENSOR BREVIS DIGITORUM PEDIS, *or* **CALCANEO-SUPER-UNGUIALIS,**

Extends over the upper ſurface of the foot, and detaches its tendons to all the five toes.

B. *In other Mammiferous Animals.*

The *monkies* have three muſcles, like man; but there is beſides, at the inner ſide of the *extenſor* *ongus pollicis*, an *abductor longus pollicis*, which is wanting in man.

Other *digitated* quadrupeds have only three muſcles like man. The *extenſor pollicis* is wanting in thoſe animals that have no pollex, as in the *dog* and the *rabbit*.

The quadrupeds with *cannon bones* have fleſhy fibres ariſing from the cannon, and inſerted into the tendon of the *extenſor longus*, which ſupplies the place of the *extenſor brevis digitorum pedis*.

In the *biſulcated* quadrupeds the internal toe has an *extenſor proprius* repreſenting the *extenſor pollicis*, but in the Solipeda it is wanting.

C. *In Birds.*

Birds have the long extenſor of the three anterior toes, anſwering to our *extenſor longus digitorum pedis*; but there is no *longus pollicis*.

Inſtead of the *extenſor digitorum brevis*, the anterior ſurface of the metatarſus is furniſhed with four diſtinct muſcles:

1. EXTENSOR POLLICIS PROPRIUS.
2. EXTENSOR DIGITI MEDII PROPRIUS.
3. ABDUCTOR DIGITI PRIMI.
4. ADDUCTOR DIGITI TERTII.

II. The flexors of the toes are:—

A. *In Man.*

THE FLEXOR LONGUS POLLICIS PEDIS, *or* Tibio= TARSO-PHALANGEUS, *and*
THE FLEXOR LONGUS DIGITORUM PEDIS, *or* TIBIO-SUB-UNGUIALIS.

Theſe are ſituated on the poſterior part of the legs, before the muſcles of the tendo Achillis. They tranſmit little tendons to the laſt phalanx of the toes. The tendons of the ſecond paſs through thoſe of the *flexor brevis.*

THE FLEXOR BREVIS DIGITORUM PEDIS, *or* CALCANEO-SUB-UNGUIALIS.

This third flexor is ſituated under the ſole of the foot. It ariſes from the os calcis, and ſends perforated tendons to the four toes.

The FLEXOR LONGUS POLLICIS ſends off a tendinous ſlip, which unites with the tendon of the *flexor longus digitorum.* This tendon has beſides a particular fleſhy maſs, ſituated above the *flexor brevis digitorum*, and riſing like it from the os calcis, but inſerted into the tendon of the *flexor longus digitorum.* This is what is called the *maſſa carnea.*

The great toe and little toe have, beſides, each its FLEXOR BREVIS PROPRIUS, (TARSO-PHALANGEUS of the great and little toes,) but they are not perforated. They are inſerted into the baſe of their firſt phalanges.

The plantar faſcia has no connexion with the *plantaris* muſcle. It is inſerted on one part into the os calcis, and on the other into the inferior heads of the metatarſal bones, and the baſes of the firſt phalanges. It is not the organ of any voluntary motion.

B. *In other Mammiferous Animals.*

In the *monkey* the flexors are differently diſpoſed.

1ſt. The *plantaris* is evidently continued along with the plantar faſcia, and communicates its action to it. 2d. The two *flexores longi* and the *brevis* are mingled together in a very complicated manner, as follows:

a. The part of the *flexor brevis* which extends to the firſt toe, is alone attached to the os calcis. It tranſmits to that toe a perforated tendon.

b. The *flexor longus pollicis* (at leaſt the muſcle analogous to that which receives this name in man,) ſends a tendon as uſual to the pollex, and two perforating tendons to the third and fourth toes.

c. The *flexor longus digitorum* ſends two perforating tendons to the ſecond and fifth toes.

d. The *three perforating tendons* of the third, fourth, and fifth toes, do not ariſe from the os calcis, as in man, but their fleſhy fibres are attached to the tendon of the *flexor longus digitorum* juſt mentioned.

e. The tendons of theſe long muſcles are ſtrongly united.

f. The *maſa carnea* is attached by a thin aponeuroſis to the tendon of the *flexor longus pollicis*, and ſends a ſtrong tendinous band to that of the *flexor longus digitorum.*

The ſhort flexors of the great and little toes are like the human. Such is the ſtructure of a vaſt number of *monkeys*, and in particular of the *mandrill.*

In ſome, indeed, it is not quite the ſame, but there is no very material difference.

In other quadrupeds the *flexor brevis digitorum* is wanting; but the *plantaris*, which is larger than that of man, or of the *monkey*, ſupplies in them the place of the *flexor perforatus.*

The *flexor digitorum longus* is in them as uſual a perforant.

Each furniſhes as many tendons as the number of toes requires; four in the *dog* and the *rabbit*, two in the Ruminantia, and one in the Solipeda.

Although the *dog*, the Ruminantia and Solipeda, have no great toe, the *flexor longus pollicis* nevertheleſs exiſts. Its tendon is intimately united with that of the *flexor digitorum perforans.* We have not obſerved it in the *rabbit.*

C. *In Birds.*

The long flexors in birds are divided into three maſſes; two placed before the muſcles of the tendo Achillis, one before thoſe, and all cloſe to the bone.

The firſt is compoſed of five portions, three of which may be regarded as forming a ſingle *flexor communis perforatus*.

It ariſes by two bellies, one coming from the external condyle of the thigh, the other from its poſterior ſurface. The latter forms directly the *perforated tendon of the middle toe*, which receives one from the peroneus. The ſecond belly ſends off thoſe of the index and little toe. In this muſcle is loſt the *acceſſorius femoralis flexorum*, a muſcle ſituated on the internal ſurface of the thigh, the tendon of which paſſes over the knee. They are united by fibres which extend from one to the other, and the tendons are inſerted into the third phalanges.

The other two muſcles of this firſt maſs are the flexors, which are at once both *perforating* and *perforated*.

They ariſe below the preceding; and one is extended to the firſt toe, the other to the *middle toe*, perforating two tendons of the preceding. They are inſerted in the laſt phalanx but one.

The other two maſſes are the *flexores perforantes*; they furniſh the tendons which go to the laſt phalanges. One belongs to the three anterior toes, the other to the poſterior. The latter ſends off a tendon, which unites with the *perforating* tendon of the *index*.

There is a *flexor brevis pollicis* ſituated on the poſterior ſide of the tarſus.

III. *Muſcles of the Toes in Reptiles.*

There is no *extenſor longus digitorum* in the *frog*. Neither is there any *flexor proprius pollicis*.

The *extenſor brevis digitorum* is very diſtinct. It ariſes from the whole length of the long external bone of the tarſus, and extends obliquely to all the four toes, the laſt excepted. It is inſerted into the laſt phalanges.

There are *ſuperior* and *inferior interoſſeous* muſcles, which are very apparent, to the number of ten. Their direction is very oblique.

The *flexor communis digitorum* is ſituated under the long bone of the tarſus, on the inner ſide, and is covered by the aponeuroſis of the gaſtrocnemius. When it reaches the little bones of the tarſus, it divides into five tendons, which receive, at their inner ſide, aſſiſtant fleſhy fibres, apparently proceeding from a muſcle ſituated below the long bone of the tarſus, on the inner ſide. It may perhaps repreſent the *flexor longus*.

In the *ſea tortoiſe* all theſe muſcles have their places ſupplied by bundles of aponeurotic fibres.

TABLE of the Length in metres of the different Parts of the Abdominal Member of Mammiferous Animals.

SPECIES	Total	Thigh	Leg	Tarſus	Meta-tarſus	Toes
Man	1,11	0,46	0,39	0,11	0,08	0,06
Sai	0,36	0,13	0,12	0,03	0,04	0,04
Orang	0,31	0,09	0,09	0,03	0,04	0,06
Pongo	0,81	0,28	0,24	0,07	0,10	0,12
Ternate Bat	0,175	0,05	0,07	0,005	0,01	0,04
Common Bat	0,06	0,02	0,02	0,01	0,005	0,005
Mole	0,065	0,02	0,02	0,005	0,01	0,01
Hedge-hog	0,12	0,03	0,04	0,015	0,02	0,015
Sea-Bear	0,93	0,35	0,27	0,11	0,09	0,11
Glutton	0,41	0,14	0,13	0,03	0,05	0,06
Racoon	0,36	0,12	0,13	0,04	0,04	0,03
Otter	0,28	0,09	0,09	0,03	0,04	0,03
Seal	0,37	0,06	0,13	0,06	0,04	0,08
Lion	1,07	0,35	0,39	0,11	0,12	0,09
Cat	0,34	0,11	0,11	0,04	0,05	0,03
Wolf	0,61	0,20	0,20	0,07	0,07	0,07
Opoſſum	0,20	0,07	0,07	0,02	0,02	0,02
Hare	0,40	0,12	0,14	0,04	0,05	0,05
Guinea Pig	0,15	0,05	0,05	0,015	0,02	0,015
Three-toed Sloth	0,37	0,11	0,11	0,04	0,03	0,08
Phatagin, or Long-tailed Manis	0,155	0,05	0,05	0,02	0,01	0,025
Elephant	1,71	0,35	0,54	0,15	0,08	0,09
Hog	0,81	0,27	0,23	0,11	0,09	0,11
Rhinoceros	1,47	0,59	0,37	0,18	0,17	0,16
Dromedary	1,57	0,50	0,40	0,15	0,33	0,19
Giraffe	2,10	0,50	0,60	0,24	0,74	0,22
Ox	1,15	0,31	0,31	0,14	0,21	0,18
Stag	1,29	0,32	0,38	0,13	0,31	0,15
Horſe	1,07	0,33	0,27	0,12	0,21	0,14
Dolphin	0	....	....	....	....	....
Porpoiſe	0	....	....	....	....	....

ARTICLE XI.

Of the Poſterior Extremity in Fiſhes.

1ſt. Of the Bones.

THE ventral fins of fiſhes take the place of the abdominal member. The ſituation and form of theſe fins vary much; they are even wanting in the family of Apodal fiſhes, as *eels*, the *gymnotus*, the *anarhicas*, &c. and in ſome genera of the Chondropterigii and Branchioſtegi, as *lampreys*, the *pipe fiſh*, and ſome ſpecies of *baliſtes*, *oſtracion*, *tetrodon*, &c.

Sometimes they are ſituated below the throat, beneath the aperture of the gills, and before the pectoral fins. Fiſhes thus conſtructed have obtained the name of *jugulares*.

Sometimes they are placed a little behind and below the pectoral fins. Theſe fiſhes have been called *thoracici*.

Laſtly, they are placed in a ſituation more analogous to that of the abdominal member in other animals, and which alſo ſeems moſt common, that is to ſay, under the belly and nearer to the anus than to the pectoral fins. Such are the fiſhes named *abdominales*.

The ventral fins are compoſed of two principal parts; one conſiſting of radii, covered with a double membrane, always appears externally, and forms what is properly called the fin. The other is internal, and repreſents the oſſa innominata, or the pelvis. It is frequently articulated with other bones of the trunk, and always receives the radii of the fin, which move upon it.

The pelvis is never articulated with the ſpine; nor does it ever form an oſſeous girdle round the abdomen. The bones which compoſe it are generally flat and of different ſhapes; they touch each other only at their internal edges.

The *ſharks* and *rays* only have a ſingle tranſverſe and nearly cylindrical bone, at the extremity of which the fins are articulated. The ſituation of the plane of the bones of the pelvis, with reſpect to the parietes of the abdomen, varies according to the ſhape of the body. In flat fiſhes theſe bones are turned obliquely, and make the keel of the belly with their internal edge. In fiſhes, with a broad or cylindrical abdomen, they form a plate more or leſs horizontal.

In the Jugular and Thoracic fiſhes, the bones of the pelvis are always articulated to the baſe of the girdle that ſupports the pectoral fins. Their figure and reſpective ſituation varies very much, as we ſhall preſently ſee.

In the *ſea dragon* and *ſtar-gazer* theſe two bones are ſoldered together at their internal edge; their inferior ſurfaces are oppoſed to each other, and leave between them an oval ſpace. The angle of their junction projects within the cavity of the abdomen.

In the *cottus*, *ſciæna*, *chætodon*, and the *perches*, the bones of the pelvis are likewiſe united by their internal edge. They are flat and long, and their external edges are directed downward, ſo as to form a foſſa.

In the *trigla cuculus*, or *red gurnard*, theſe bones are only united at the poſterior extremity of their inner edge. They are very broad, flat, and form an oval ſhield, the middle part of which is furrowed, and the poſterior extremity long and pointed.

The bones of the pelvis of the *pleuronectes* bear the fins at their anterior extremity; they are united into a quadrangular pyramid, the point of which tends upward and backward, and its baſe forward.

In ſome of the *gaſteroſteus* the bones of the pelvis are ſeparate, extremely long, and receive near their middle a moveable ſpine that occupies the place of the fin.

The *dory* (*zeus faber*, Linn.) has the bones of the pelvis triangular and flat; they touch each other in the whole of that part which ſhould be the loweſt ſurface. Their anterior angle is rounded, and receives the fin; the two others are very long and acute. One is ſituated within the abdomen, the other over the ſide of the ſternum outwardly. In the *zeus vomer* theſe bones are very ſmall and cylindrical.

In Abdominal fiſhes the bones of the pelvis are never articulated to the ſhoulder, or the girdle of the pectoral fins. They are ſituated on the middle and inferior part of the belly, at different diſtances from the anus.

Theſe bones are in general unconnected with each other, and are preſerved in their ſituation by ligaments. In *carps* they are long, and only touch about one-third from the lower end. In *herrings* they are very ſmall, cloſe, and form an addition to the little bones that ſupply the place of the ſternum.

Thoſe of the *common pike* are broad, triangular, and cloſe together at the anterior end, but diverge at the poſterior extremity, which is broader, and receives the fin.

In the *anableps* they are very far aſunder, and bear upon their external border a very long ſpine, which aſcends towards the vertebral column, and is inflected in the direction of the ribs.

In the *ſiluri* the bones of the pelvis are united together: they take the ſhape of an eſcutcheon, round in the middle, and often ſpinous in front. The fins are attached to their external and poſterior edge.

Laſtly, in the *loricaria* the bones of the pelvis are oſſified into one piece, the poſterior groove of which forms an aperture for the anus. The fins are articulated to the outward edge.

The fin properly ſo called, in ordinary fiſhes, conſiſts of a certain number of bony radii, either ſimple or forked, ſupported by one or two rows of little oſſicula placed between them and the bones of the pelvis. The rays which form the fin move upon the oſſicula, ſo as to open and cloſe like the ſticks of a fan. This movement produces the expanſion and folding of the fin; but there is ſtill another motion, both of the whole fin, and of its oſſicula, upon the bones of the pelvis, by which the fin is alternately raiſed and brought cloſe to the body.

The radii of the ventral fins are for the moſt part ſhorter than thoſe of the pectoral fins.

The ventral fin of the Chondropterygii has a peculiar conformation. Two principal cartilages are articulated upon the extremity of the bone of the pelvis: the one, which is external, forms a kind of finger of ſeven or eight joints; the other, which is internal, receives all the remaining radii of the fin, frequently to the number of thirty or more.

2d. *Of the Muſcles.*

The ventral fins move up and down, as well as inwardly and outwardly. The muſcles which move them from above downward, or depreſs them, are ſituated on the external or inferior ſurface of the pelvis. Thoſe which elevate them are ſituated on the upper or abdominal ſurface of thoſe bones.

There is commonly but one muſcle for depreſſing the ventral fin; it occupies all the inferior ſurface of the bone of the pelvis. In Jugular and Thoracic fiſhes, it even extends as far as the clavicle: it terminates by ſeveral little tendinous ſlips which are inſerted into the oſſicula and baſes of the radii. At the ſame time that this muſcle, by the general contraction of its fibres, depreſſes the fin, it pulls its two edges aſunder in ſuch a manner as to unfold or ſpread it.

The muſcles which raiſe the ventral fins are only two, ſituated on the abdominal ſurface of the bone of the pelvis. That neareſt the middle is of a pyramidal figure, the oſſicula which ſupport the radii are attached to it throughout the whole length of its baſe. It pulls the fin backward, at the ſame time that it removes the external edge from the middle line.

The muſcle the moſt remote from that line lies directly over the abdominal ſurface of the bone of the pelvis, and is partly concealed by the preceding. It is the larger of the two. Its fibres run obliquely from without inwardly towards the internal border of the ventral fin, which it moves outwardly, at the ſame time that it carries the whole fin backward.

There are beſides, at the baſe, or articulation of the radii of the fin with the inter-articular oſſicula, little muſcles perfectly analogous to thoſe we demonſtrated in treating of the motion of the fin of the tail.

In the genus *cyclopterus,* the ventral fins are united to each other by a membrane, and form a kind of funnel below the pectoral fins.

In the genus *gobuis*, the two fins only form a ſingle one, placed before the anus.

The muſcles of the ventral fins of the *ray* genus, are diſpoſed nearly in the ſame manner as thoſe of the pectoral fins.

LECTURE SIXTH.

OF THE ORGANS OF MOTION IN ANIMALS WITHOUT VERTEBRÆ.

ARTICLE I.

Organs of Motion in Molluſca Cephalopoda.

THE molluſca that have the head furniſhed with long appendages for progreſſive motion, are called *cephalopoda*, and have two orders of muſcles, one belonging to the body, the other to the feet or *tentacula*.

1. *Muſcles of the Body.*

The ſack which compoſes the body of theſe animals, ſtripped of the external ſkin, preſents a muſcular tiſſue of very compact fibres. Thoſe of the outward layer appear to have a longitudinal direction; the middle layer is tranſverſe; and the layers of fibres that ſucceed theſe have different obliquities. They all act in ſuch a manner as to flatten, to elongate, to twiſt, and to bend the ſack; but the action of each of the layers cannot be aſſigned in a poſitive manner, on account of their very complicated ſtructure.

In the back of theſe animals, under the ſkin, there is found a body more or leſs ſolid. In the *cuttle fiſh* it is a ſpecies of bone compoſed of different thin parallel plates one above another, and ſeparated by little columns diſpoſed in the form of a quincunx. This bone is oval, thick towards the middle, and thin at the circumference. In other ſpecies its form varies much, but its ſubſtance is generally elaſtic, and tranſparent like glaſs. Its ſurface is ſometimes marked with longitudinal furrows.

The *ſepia octopus* wants it entirely.

Two ſtrong muſcles ariſe from the inner ſurface of the ſack, on each ſide of this bone. They run towards the head, and, on their arrival there, divide each into two branches. One branch is inſerted into the head; the other mixes its fibres with thoſe of the ſack, at the edge of which it ends.

2. *Muſcles of the Foot.*

The Cephalopoda have eight conical feet, of different lengths, arranged in a circle at the top of the head, round the mouth. The animal can turn and bend them in every direction, and faſten itſelf to bodies by help of the cups or ſuckers with which they are furniſhed. The muſcles which perform theſe motions are very numerous; they may, however, be diſtinguiſhed into thoſe that are common to the whole foot, and thoſe that are proper to the ſuckers.

Below the ſkin we find a very thin muſcle, the fibres of which are united by a looſe cellular ſubſtance. It accompanies the ſkin in all its different ſhapes, and may perhaps be regarded as a *muſculus cutaneus* employed to corrugate the ſkin, and give greater force to the muſcle ſituated within it, and upon which it acts like a girdle.

Between the feet, and under the ſkin which unites them at the baſe, we find two thin muſcles ſituated one below the other, the fibres of which are tranſverſe. One ariſes in the middle longitudinal line of the foot on the ſide oppoſite to the ſuckers, and proceeds directly to its inſertion in the ſame line of the adjacent foot on either ſide.

The other ariſes below the ſuckers themſelves, goes over the lateral parts of the foot, and, at laſt, forms a muſcular membrane with tranſverſe fibres, which paſſes under the preceding muſcle, and proceeds to its inſertion in the other foot, exactly in the ſame manner as it took its origin. This double muſcular membrane bears ſome analogy to that which unites the toes of web-footed birds, ſuch as *ducks*, *geeſe*, &c. It produces a circular plate, which occupies the intervals between each baſe of the feet. Theſe two muſcles probably ſerve to bring the feet nearer to each other; the ſecond may beſides ſeparate the two rows of ſuckers. It reaches the whole length of the foot, but it becomes thinner towards the extremity.

Below theſe three layers of muſcles (the two *tranſverſales* and the *cutaneus*,) we find another pretty large one, the conical figure of which determines the ſhape of the foot. At the ſurface it ſeems entirely formed of tranſverſe fibres; but on cutting it in different directions, we find that it has longitudinal fibres. Theſe fibres are interwoven preciſely like thoſe of the human lingual muſcle towards its centre. In the centre of this muſcle there is a vacant ſpace, in which we find very large veſſels and nerves.

The ſuckers are faſtened to the inferior ſurface of this muſcle, and to a layer of fibres ſtill more evidently longitudinal, by little fleſhy bands, differing in direction according to the ſpecies. It is thought that the cylindrical muſcle ſerves to embrace bodies. Its ſtructure is conformable to the action it produces.

3. *Muſcles of the Suckers.*

The ſuckers are formed by a muſcular cup of radiated fibres, which, by their contraction, diminiſh its capacity. But at its edge, and cloſe to the plate under the cylindrical muſcle, there is another layer of circular fibres, like a ſphincter, which renders the cup more convex. Finally, each ſucker is retained, and moved upon the foot by little muſcular faſciculi interlaced together, and uniting at laſt in the inferior tranſverſe muſcle of the foot. At leaſt this is the caſe in the *ſepia octopus.*

In the *calmar (ſepia loligo),* and the *cuttle fiſh,* the ſuckers are attached by very ſmall muſcular peduncles.

When an animal of this kind approaches any body with its ſuckers, in order to apply them more intimately, it preſents them in a flat or plain ſtate; and when the ſuckers are thus fixed by the harmony of ſurfaces, the animal contracts the ſphincter, and forms a cavity in the centre, which becomes a vacuum. By this contrivance the ſucker adheres to the ſurface with a force proportioned to its area and the weight of the column of air and water of which it conſtitutes the baſe. This force, multiplied by the number of ſuckers, gives that by which all or a part of the feet adhere to any body. This power of adheſion is ſuch, that it is eaſier to tear off the feet than to ſeparate them from the ſubſtance to which the animal chooſes to attach itſelf.

In the *cuttle fiſh* and the *calmars,* the mouth of the ſucker is ſurrounded by a cartilaginous indented zone; in the *octopus* it is only a fleſhy diſk, flat, and perforated in the middle.

Beſides the eight feet which we have juſt deſcribed, and which are all that are poſſeſſed by the *octopus*, the *cuttle-fiſh*, and the Calmar, have two others that are much longer, much ſmaller, and have no ſuckers, except at the extremity, which is enlarged. Their ſtructure is in other reſpects the ſame as that of the other feet.

ARTICLE II.

Organs of Motion in Molluſca Gaſteropoda.

WE ſhall not here deſcribe the muſcles that ſerve for maſtication or deglutition; nor thoſe that are appropriated to the organs of generation, ſmelling, ſight, and feeling: theſe we ſhall particularly explain in treating of the functions to which they belong.

As to the organs of locomotion in the Gaſteropoda, they principally reſide in that inferior part of the body on which they drag themſelves forward, and which is called their foot. It is a fleſhy maſs, formed of fibres which croſs each other in ſeveral directions, and give to it every poſſible ſhape. Moſt commonly it has that of an oval, pointed behind; but by the various contractions of which theſe fibres are ſuſceptible, they extend or contract it in whole or in part, ſo as to produce that ſlow progreſſive motion which every body has remarked in the common *ſnail* or *ſlug*.

The tranſverſe muſcular fibres are eaſily ſeen in the foot of the *ſlug*, if it be opened by the back. They proceed from the edges of the foot to two longitudinal, middle, tendinous lines. Below theſe we meet with others in a contrary direction, but ſo interwoven that it is difficult to trace the layers.

In the *ſcyllæa*, the foot is only a longitudinal furrow, impreſſed in the whole length of the belly of the animal. By the help of this furrow the animal embraces the ſtalks of the fucus upon which it crawls. In other reſpects, the organization of its foot is nearly the ſame as that of the *ſlug*.

In the *limpet*, the moſt inferior layer is compoſed of tranſverſe fibres, which, at the edge, are interlaced with a great number of others that are circular. The ſuperior layer is a muſcle compoſed of two rows of fibres, which meet and form an acute angle upon a middle line, which correſponds to the long diameter of the foot. There are alſo at its edge ſome circular fibres.

The inferior layer, by its contractions, lengthens the ellipſis of the foot, while it leſſens its breadth; and the ſuperior diminiſhes the length, but increaſes the breadth. This is the mechaniſm which produces the progreſſion of theſe animals. Laſtly, the circular fibres diminiſh the ſurface on all ſides, and render it convex above, thereby producing a vacuum, which makes the animal adhere firmly to the ſurface that ſupports it.

The gaſteropodal molluſca, which are covered with one or more ſhells, and are called *teſtacea*, have, beſides the muſcles of the naked gaſteropoda, others that enable them to retreat into the ſhell, and protrude their body from it again.

Theſe ſhells, or moveable habitations, vary much in their form. They are moſt generally made of one piece of different ſhapes, ſimple, without twiſting, as in the *limpet*; in a flattened ſpire, as in the *planorbis*; in a globular and pyramidal ſpire, as in the ſhell of the *ſnail*, *bulimus*, *dipper-ſnail*, &c.

There is but one ſingle genus of the gaſteropoda, the *chiton*, which has a ſhell formed of ſeveral pieces.

In the *limpet*, the foot is faſtened to the circumference of the ſhell by a ring of fibres which are attached all round the ſhell, and which, after piercing the outward covering or cloak, are inſerted in the edges of the foot, and interlaced with its circular fibres. Anteriorly they leave a free ſpace for the paſſage of the head. This muſcle, by its contractions, brings the foot and the ſhell cloſer together, and compreſſes the body; on relaxing, it allows the ſhell to be raiſed up by the elaſticity of the body.

In the *garden ſnail*, there are two ſtrong muſcles which draw the foot and the whole body within the ſhell. They ariſe from the columella, or axis of the ſhell, and having penetrated the body below its ſpiral part, they run forward under the ſtomach, and ſpread their fibres in ſeveral

veral ſlips which interlace with thoſe of the muſcles proper to the foot, the ſubſtance of which they enter. From theſe attachments their mode of action may very eaſily be comprehended.

When the animal wiſhes to protrude itſelf from the ſhell, its head and foot are forced out by circular fibres which ſurround the body immediately above the foot.

ARTICLE III.

Organs of Motion in Molluſca Acephala.

THE acephalous molluſca have the body enveloped by a membrane principally muſcular, which is called the *cloak.* This fleſhy integument is more or leſs complete according to the genus, as will be ſeen hereafter.

The cloak is generally covered by valves, or ſhells of various forms and proportions. Few of the genera want this ſolid covering; among theſe, however, are the *aſcidia* and *ſalpa.*

The valves of the ſhells are ſo diſpoſed that they can move one upon another, by means of oſſeous projections, which reciprocally receive each other, thus forming a real hinge. They are beſides connected by an elaſtic ligament of a horny ſubſtance which tends continually to open them.

The hinge of the ſhells preſents ſo many varieties, that naturaliſts have drawn from it the characteriſtics of the genera.

In fact, the *oyſter*, the *placuna*, the *ſcallop*, the *avicula*, *&c.* have no tooth in their joint. The *piddocks*, and the *mya*, or *gapers*, have it only upon one of the valves; but it is not received into a foſſa. The razor-ſhells have the hinge ſtrengthened by a tooth in each ſhell which projects inward. Theſe two projections meet and move upon each other.

The *anomia*, the *unio*, the *ſpondilus*, or *thorny-oyſter*, the *chama*, and ſeveral others, have one or two teeth upon one valve only, which are received into correſponding cavities in the oppoſite valve. The *venus*, the *cockle*, and the *mactra*, have teeth on each ſhell, which are mutually received. Finally, the *arca* has a multitude of little teeth which are cloſely indented with each other.

Theſe different conformations ſerve either to facilitate the motions of the hinges, or to ſtrengthen the joint; or they permit a greater or leſs opening of the valves.

The elaſtic ligament, which tends continually to open the valves, is not always ſituated at the ſame point of the ſhell. The *muſcles*, for example, have the ligament at one ſide of the valves. The *placuna* have a little oſſeous appendage, which forms a projection in the inſide of each valve; and from this ariſes the ligament that holds them together. The *perna* has in each valve ſeveral little cavities oppoſite to each other in pairs, in which an equal number of ſmall ligaments are lodged.

The ſhells of the acephala preſent ſeveral other peculiarities. We find the valves immoveable, and ſoldered together at the angle in *pinna*. The *teredo*, or *pipe-worm*, has the body encloſed in a calcareous tube, and is armed with two little moveable valves, which are uſed in penetrating wood. The *terebratula* has, on the inner part of one of the valves, two oſſeous appendages which ſupport the body.

The contractile membrane which covers all the body of the acephalous molluſca, and is called the *cloak*, is a real muſcle, which preſents a great many varieties. Sometimes, and indeed moſt commonly, it is open before, in the direction of the valves, as in the *oyſter*, the *muſcle*, *&c.*; ſometimes in the ſhells that have two ends always open, as the *raſor-ſhells*, the *gapers*, the *piddock*, *&c.* it is perforated at both extremities. Laſtly, the cloak envelopes the whole body of the animal, and, like a ſack, is open at one end only; this may be obſerved in the *aſcidia*.

The cloak of the *oyſter* is compoſed of two pieces of the ſame form as the ſhell; they are fixed to the body poſteriorly, or on the ſide of the hinge, and extend to the edges of the valves. Their ſubſtance is ſoft, ſemi-tranſparent, and furniſhed with a number of muſcular bands. They are perforated by the muſcle which cloſes the ſhells. One of the edges is in folds, like a flounce, and feſtooned. The other is furniſhed with ſmall conical and contractile tentacula.

The cloak of the other acephala differs from what we have deſcribed above, in its general form: in the tentacula on its edge; in the tubes which are prolongations of it; and, laſtly, in the muſcles which perforate it.

The aperture which ſerves for the ejection of the excrements, and that which receives water, and the different aliments, are ſometimes prolonged into a kind of tube, which is a continuation of the cloak: this is called a *proboſcis*. The *oyſter*, the *muſcle*, the *unio*, and the *anodontites* have only one of theſe apertures, which is the anus. The water merely enters by the large ſlit in the cloak. In the *cockle*, each aperture is a few lines elongated. That which ſerves for reſpiration is longer and larger than the other. They are ſtill more elongated and unequal in the *venus*, the *tellina*, the *mactra*, and ſome other genera. The *raſor-ſhell* has likewiſe two; but in the *piddock* both tubes are encloſed in a very thick fleſhy proboſcis, through the whole length of which they paſs without uniting.

In the acephala that have the cloak open before, the tentacula are placed at the edge of the cloak, and in particular towards the anus; but in thoſe that have tubes they are ſituated at the orifice of the proboſcis. In the edible muſcle, *(mytilus edulis* Linnæi,) they are branched.

The valves of ſhells having a continual tendency to open, in conſequence of the action of the elaſtic ligament ſituated at the ſide of the hinge which operates as a muſcle, it was neceſſary that the contained animal ſhould have the power of cloſing them at pleaſure. There are, therefore, according to the different genera, always one or two muſcles fitted for this purpoſe.

In the *oyſter* there is only one muſcle of this kind, ſituated near the centre of the ſhell, behind the liver, and in the middle of the cloak. It is inſerted into both valves, and, by its contraction, brings them together with an aſtoniſhing force. The ſame mechaniſm prevails in the *perna*, *avicula*, and *ſpondylus*.

There are two muſcles for cloſing the ſhell in the *muſcle*, *raſor-ſhells*, *venus*, *mactra*, *cockle*, *&c.* They are always ſeparate from each other towards the extremities of long ſhells, and generally approximate at the edge on which the hinge is ſituated, in order that a very ſmall relaxation on their part may produce a large opening on the oppoſite ſide.

A great number of the acephalous molluſca have the power of removing their teſtaceous covering from one place to another, by the help of a muſcular appendix which they can protrude and retract at pleaſure, with which they faſten [illegible] themſelves to the ſand and rocks, and drag themſelves along. This appendix is called the *foot* of the animal.

The *common oyſter*, the *ſpondylus* or *thorny oyſter*, ſome ſpecies of the *ſcallop*, the *anomia*, and in general all the mollufca that have ſhells with unequal valves, have no foot, and are therefore deprived of the means of voluntary locomotion.

One of the moſt ſimple of theſe feet is that of the *anodontites* of *ponds*, (*mytilus anatinus* Linnæi.) It is ſituated before the body towards the margin of the ſhells. Its form is a compreſſed oblong. We obſerve on each ſide, externally, a layer of fibres proceeding from the bottom of the ſhell. There are alſo ſome internal fibres which croſs each other at right angles, and others unite the two external layers, to which they are attached in a circular manner. From this diſpoſition it will eaſily be conceived that the animal may, when it pleaſes, change the three dimenſions of the foot, or of one of its parts: by this means it is enabled to place its ſhell flat on the ground, and to crawl along like the ſnail by the help of its foot.

We find this ſimple foot in the *piddock*. Its form is almoſt ſpherical, and truncated by a flat ſurface. The part which Linnæus has obſerved in the *raſor-ſhell*, and which he compares to a glans in its prepuce, is the foot by which the animal buries itſelf in the ſand, or riſes to the ſurface. In theſe two genera the foot is protruded ed at the aperture of the ſhell, which is oppoſite to that through which the tubes paſs.

The foot of the *cardium* or *cockle* is ſomewhat complex. It has a triangular appendix, which is capable of inflexion, of ſeizing with its point the glutinous matter, and drawing it out into threads. But the foot of the ſea-muſcle *(mytilus edulis)* is moſt remarkable in its organization. It reſembles a ſmall tongue, marked with a longitudinal furrow, ſuſceptible of conſiderable elongation, and of being ſhortened into the form of a heart. This organ is moved by five muſcles on each ſide. Two ariſe from the extremities of the ſhell, near thoſe which cloſe it: the other three come from the bottom of the ſhell and the depreſſion for the *nates*. They are all inſerted into the foot, with the fibres of which they are interwoven, in the ſame manner as the external muſcles of the human tongue join the lingual. The organ is completely enveloped in a ſheath formed of tranſverſe and circular fibres of an obſcure purple colour. This foot is employed both in ſpinning and crawling; the laſt office is performed as in all the other bivalves: it accompliſhes the firſt by ſeizing, with its point, the gluten ſupplied by a gland ſituated under its baſe, and drawing it out into threads in the above-mentioned furrow.

The gland that ſecretes this humour, of which the thread is formed, ſhall be deſcribed hereafter.

ARTICLE IV.

Organs of Motion in Cruſtacea.

THE muſcular ſyſtem of the Cruſtacea is confined to the motions of the legs, the tail, and the falſe feet: in this claſs there are no muſcles for moving the head on the corcelet, as theſe two parts are united together. The antennæ, the mandibles, and the palpi, have their true particular muſcles; but we ſhall not deſcribe them until we have occaſion to treat of the organs to which they belong.

I. OF THE TAIL.

The tail is a principal part of the body in the greater number of the Cruſtacea. It is a very ſtrong and moveable member, which thoſe animals employ with great advantage both in leaping and ſwimming.

1. *Solid Parts of the Tail.*

In ſeveral *monoculi*, the tail is compoſed of long fillets, which in the *polyphemus* are ſolid, and moveable on the baſe only.

The *crabs* have the tail ſhort, flat, and bent under the body, in a depreſſion ſituated between the feet.

The *pagurus*, or *hermit crab*, which is in the habit of introducing itſelf into empty ſhells, or any accidental cavity in a ſtone, has a ſoft tail without ſcales.

The tail of the *cray-fiſh*, properly ſo called, merits a particular deſcription. It is formed of ſix principal ſegments, and terminates in five laminæ. The ſegments vary a little with reſpect to their form. On the upper part they are convex and imbricated: beneath they are narrower, and united by a looſe membrane which admits of much motion. At the angle where the inferior portion joins the dorſal, theſe ſegments are furniſhed with a kind of cruſtaceous fins, bordered with cilia, and conſiſting of ſeveral articulations. Theſe are called *pedes nothi*, or *pedes natatorii*. They are moved forward and backward, and a little outward and inward, by ſmall muſcles contained within each articulation; but which do not differ ſo much from thoſe of the real feet as to require a particular deſcription.

Of the five laminæ which terminate the tail, two are pairs, and one ſingle. The middle one is immediately articulated with the laſt ſegment. The aperture of the anus is ſituated under this lamina. In ſome ſpecies it ſeems broken in the middle, and capable of a ſmall degree of motion. The two lateral laminæ are ſupported by a common piece, which is articulated with the laſt ſegment of the tail. The moſt internal lamina is ſimple and ciliated at its extremity only, like that of the middle; but the external ſeems articulated about one-third of its length from the lower end; or it may rather be ſaid to be formed of two portions; the firſt, covering with its extremity, which is denticulated, the ſmaller, which follows it, and which has its margin furniſhed with very cloſe cilia.

The muſcles which move this tail have ſo ſingular a conformation, that it appears neceſſary to give a ſort of monographical deſcription of them.

2. *Muſcles of the Tail.*

The muſcles of the tail in *cray-fiſh* form two maſſes, diſtinguiſhed from each other by the inteſtinal canal. The dorſal maſs is the thinneſt, and leaſt complex. We obſerve in it three kinds of fibres.

The firſt form a muſcle which ariſes from the dorſal portion of the corcelet, about one-fourth of its length forward from the poſterior end. It is afterwards directed obliquely from before backward, and from within outward, to the lateral parts of the firſt ſegment of the tail, into which it is inſerted. When the muſcle of one ſide acts ſeparately, it moves the tail to the right or left; when they act both together, they raiſe the tail, if it has been inflected, and preſerve it ſtraight.

The ſecond and the third ſeries of muſcular fibres extend throughout the whole length of the back in two parallel and very contiguous lines. They ariſe from the lateral and ſuperior parts of the ſeptum of the corcelet to which the branchiæ are applied; they are attached to theſe parts by ſeveral digitations. Upon tracing them to the firſt ring of the tail, we find on the ſurface a ſmall interſection, and obſerve that a little bundle of fibres turns off to be inſerted in this firſt annular ſegment. A ſimilar inſertion takes place in each ſucceeding ring. This diſpoſition gives to the internal band the appearance of a twiſted cord.

The external dorſal maſs is formed of diſtinct longitudinal fibres.

Theſe three orders of muſcles very much reſemble the ſtraight muſcles of the back of caterpillars, as will be ſeen hereafter.

The ventral maſs of the muſcles of the tail is thicker and more complicated than the dorſal. To give a correct idea of its compoſition, we ſhall deſcribe its appearance on the view of three different ſurfaces. We ſhall firſt deſcribe its back, or ſuperior ſurface, the muſcles of which we have already ſpoken, as well as the inteſtinal canal being removed; next, its inferior ſurface, the ſcales below the tail and the nerves being removed; finally, an internal lateral ſurface, produced by the longitudinal biſection of the muſcle, to ſhew its interior ſtructure.

The ventral muſcle of the tail, viewed on the dorſal ſurface, ariſes from the inſide of the thorax, above the oſſeous cancellated part which incloſes the muſcles of the coxa. This muſcle then divides into two, a right and a left, each compoſed of three large digitations. At the firſt ſegment of the abdomen the longitudinal fibres ſink under others which are twiſted round them. The remainder of the muſcle, throughout the whole length of the tail, is alſo formed of two ſeries of convex and incurvated fibres, parallel to each other, and ſeparated by a gutter, in which the inteſtinal canal is lodged.

Viewed inferiorly, the ſame muſcle exhibits three very diſtinct orders of fibres. The firſt ſeries is produced by the inferior ſurface of the digitations, which are inſerted into the oſſeous cancelli of the thorax. The ſecond ſeries is formed of oblique fibres, which are continuations of thoſe of the firſt, and which extend from the middle line, where the medullary cord of the nerves is ſituated, to the lateral parts of the rings, at the angle formed by the dorſal and ventral portion. There are two ſtrong bundles of fibres to each angle of the rings, from the firſt to the ſixth. The third ſeries is produced by ſingle bundles of tranſverſe fibres, which deſcribe arches, with their convexity downward. Theſe flat muſcular hoops correſpond to the interſection of each of the rings, and appear to form an equal number of derivative pulleys for the oblique fibres we have juſt deſcribed.

Finally, the ventral muſcle of the tail, when biſected longitudinally, exhibits the appearance of a rope, the ſpiral twiſts of which have little obliquity. The fibres which correſpond to the tranſverſe bundles are diſtinct, but narrower.

It reſults from this ſingular complication, that the muſcle, when detached from the parts to which it adheres, reſembles a very cloſe twiſt, the threads of which, inſtead of acting longitudinally, move obliquely in the canal formed by the neighbouring fibres.

II. OF THE FEET.

The feet of the Cruſtacea vary with reſpect to their number and their form. In the *monoculi* they aſſume very different figures: ſometimes they ſerve inſtead of feelers, jaws, fins, gills, &c. Their form is alſo very various in the genus *Cancer*. As an example of the organs of motion in the feet, we ſhall deſcribe thoſe of the cray-fiſh ſpecies.

1. *Solid Parts of the Feet.*

The *cray-fiſh* have commonly five feet on each ſide. They are all formed with ſix joints.

The firſt pair is the longeſt, and forms what is called the *pincers* or *claws*.

The *coxa* is connected with the thorax. The only direction in which it can move is backward and forward. It ſupports one of the diviſions of the branchiæ, and the ſecond portion of the foot, which repreſents the *femur*. This is flat, ſhort, nearly ſquare, ſmooth, and a little bent. The plane of its articulation is parallel to the length of the part. As the two muſcles which move it are inſerted in the two moſt diſtant points, the femur is ſituated horizontally. It moves by a hinge upon the coxa. The motion is compound, the member being directed both backward and forward, and outward and inward. Its motion, with reſpect to the *tibia*, is very limited, being merely upward and downward: by this motion it is applied to the thorax. The third joint, which anſwers to the *tibia*, is alſo ſomewhat flat, particularly at its femoral extremity: it is incurvated a little in the direction of the femur, and thus correſponds with the convexity formed by the corcelet. At its tarſal extremity, the tibia becomes thick, broad, and ſpinous. Its motion on the femur is very limited. The fourth articulation is intermediate between the pincers and the tibia, on which it moves at a very conſpicuous angle. The *pincer* makes the fifth articulation, which is the largeſt of all. It terminates on the external ſide by a ſharp ſpinous proceſs, and receives, on the internal ſide, a moveable pollex, capable of being oppoſed to it. The movement of the pincer on the fourth articulation is outward and inward.

The two ſucceeding pairs of feet, though much ſmaller, alſo reſemble pincers, with this difference,

ence, that the pollex, or the articulation which repreſents it, is not thicker than the immoveable part.

The two laſt pairs are not, like the three former, terminated by pincers, but by a ſingle moveable *claw* or *nail*. In other reſpects they are ſimilar to the ſecond and third pairs.

2. *Muſcles of the Feet.*

Each articulation of the feet has two muſcles, an extenſor and a flexor.

The extenſor of the coxa is ſituated within the corcelet, on the cornuous portion which ſupports the branchiæ, a little before the coxa, which it moves forward.

The flexor of the coxa is alſo attached to the horny part that ſuſtains the branchiæ; but it is ſituated poſteriorly, and the motion it produces is the oppoſite of the preceding.

The extenſor of the femur is ſtronger than the flexor. It ariſes within the coxa, from its anterior portion, and is inſerted into the ſuperior eminence of the articulation of the femur. It ought rather to be called a depreſſor.

The flexor of the femur, or more properly the levator, is ſhorter than the preceding. It occupies the poſterior internal part of the femur, and is inſerted into the inferior eminence of its articulation.

The extenſor of the tibia occupies the whole length of the femur internally. It is inſerted into the external margin of the articulation of the tibia.

The flexor of the tibia is not ſo ſtrong as its extenſor. It lies under it, and is inſerted into the internal edge of the articulation.

The extenſor of the firſt part of the tarſus ariſes internally from the whole of the ſuperior edge of the tibia, and is inſerted into the moſt elevated eminence in the fourth articulation.

The flexor of the ſame piece ariſes likewiſe within the tibia, but from its inferior border: it is inſerted into the loweſt eminence of the articulation.

The extenſor and the flexor of the pincer occupy and divide the interior of the fourth articulation. Their ſituation determines their functions.

The extenſor of the pollex is a very ſmall muſcle, which fills the ſuperior part of the pincer.

The flexor pollicis ariſes from the whole of the other part of the claw. It has an intermediate oſſeous tendon, which is ſtrong, flat, and oblong. It is very large.

ARTICLE V.

Organs of Motion in the Larvæ of Inſects.

THE transformations which inſects experience at different periods of their exiſtence, occaſion great variety in their organs of motion. It is therefore neceſſary to examine them in all the different ſtates through which they paſs, if we would acquire an accurate knowledge of this claſs of animals, with reſpect to theſe parts.

All the winged inſects which undergo a complete metamorphoſis, differ conſiderably, in their firſt ſtate, from thoſe which they afterwards aſſume. The principal of theſe differences conſiſts in their organs of motion. In this firſt ſtate they are called *larvæ* or *caterpillars*. The animal exiſts in the larva form for a certain time, after it has left the egg.

Inſects, while in this ſtate, are covered by a ſoft tender ſkin, divided into ſegments or rings, capable of being moved towards each other by muſcular bands ſituated within the body.

The motion of inſects is frequently performed on theſe rings only, either in the manner of reptiles, or by reſting alternately each ſegment of the body on the plane which ſupports it. Such is that of the larvæ of the Diptera, or two-winged inſects, and a great number of the Hymenoptera.

Sometimes the ſurfaces of theſe rings are covered by ſpines, ſtiff briſtles, or hooks, which ſtrengthen their hold on other bodies. This may be obſerved in ſome ſpecies of *flies*, *gad-flies*, *tipula*, *ſtratyomis*, *ſyrphius*, &c.

The body of the larva, in ſome orders of inſects, has inferiorly, and towards the head, ſix feet, each formed of three ſmall joints, the laſt of which is ſcaly, and terminates in a hook. By oppoſing theſe members to one another, the inſect is enabled to embrace a portion of adjacent bodies, to hook itſelf to them, and afterwards draw the remainder of its body towards that fixed point. This is the uſual conformation of the larvæ of the Coleoptera, and a number of thoſe of the Neuroptera.

The other larvæ of the Coleoptera, which live in wood, as the *cerambix*, the *wood beetle*, the *rhagium*, &c. have the ſix feet exceedingly ſhort, and almoſt obliterated, or of no uſe.

These move in ſinuoſities, formed with their mandibles, which alſo ſerve to hook them to other bodies, and by the help of plates or tubercles that riſe out of their ſkin on the back and belly. This gives to their body a tetrahedrous form. The manner of their motion may be compared to that of chimney ſweepers aſcending a funnel.

The Lepidoptera and the larvæ of ſome genera of the Hymenoptera have, beſides the ſix ſcaly articulated feet, a variable number of other falſe feet, which are not jointed, but terminate in hooks diſpoſed in circles and ſemicircles. Theſe hooks, which are attached to the ſkin by appendices or retractile tubercles, ſerve as cramps to aſſiſt their motion on other bodies.

The larvæ of the inſects which undergo only a ſemi-metamorphoſis, as the Hemiptera; and of thoſe which experience no transformation whatever, as the Aptera, the *flea* excepted, differ nothing from the perfect inſect with reſpect to the feet.

After this account of the external organs of motion in larvæ, it may ſtill be uſeful to give a particular explanation of the muſcles of ſome of them. We ſhall therefore deſcribe in ſucceſſion, 1. The Muſcles of *Caterpillars;* 2. of the Larva of a *Scarabæus*, which lives under ground; 3. of a *Hydrophilus*, which ſwims; and, 4. of a *Cerambix*, which inhabits the crevices of wood.

1. *Muſcles of Caterpillars.*

The deepeſt layer of muſcles in the caterpillar is formed of four principal diviſions; two correſponding to the back, and two to the belly. Their direction is longitudinal.

Thoſe of the back are ſeparated from each other by the longitudinal veſſel, and from thoſe of the belly by the tracheæ.

They begin at the union of the firſt ring with the ſecond, by two faſciculi of fibres ſomewhat ſeparate from each other, which are inſerted into a kind of tendinous line, produced by the union of the ſecond ring with the third. The ſame arrangement prevails between all the annular ſegments of the body. Upon the third ring, the fibres of the two faſciculi, although ſtill diſtinct, are much more groſs. On the fourth ring, the internal faſciculus only has the fibres ſeparate. The fibre is continued, without any apparent interſection, over all the other rings. It diminiſhes in thickneſs towards the laſt, and again forms ſeveral faſciculi, firſt three, then four, and laſtly five or ſix.

Theſe muſcles, by their contraction, ſhorten the body when they act with thoſe of the belly; when they act ſeparately, they bend it upward.

The longitudinal muſcles of the belly are ſeparated from each other by the medullary cord, and from thoſe of the back by the tracheæ. They have preciſely the ſame direction. They likewiſe commence at the union of the firſt ring with the ſecond, by numerous faſciculi, which unite at the third ring, where they ſeem to form only a ſingle maſs. The fibres afterwards ſeparate higher or lower according to the ſpecies, and form four or five fleſhy cords, which terminate at the laſt pair of falſe feet.

Theſe aſſiſt the dorſal muſcles in ſhortening the body: when they act ſeparately, however, they are the opponents of the former, for they then bend the body downward.

Between the long muſcles of the back and the ſkin there are others which are ſhort; but their direction is oblique.

Some of theſe are extended from the outſide inwardly, towards the dorſal line, between the annular interſections.

The others are ſituated in the ſame interval, but their direction is oppoſite. They proceed from the inſide outwardly, and form, with the preceding muſcles, an angle like the letter V.

Theſe two kinds of oblique muſcles have not an equal quantity of fibres in every part. Thoſe which are ſituated in the firſt rings are the longeſt and narroweſt. Thoſe of the fourth, fifth, and ſixth, are much ſhorter. In ſome ſpecies they afterwards become longer and more numerous. In others, on the contrary, they continue broad and ſhort.

Theſe fibres act ſeparately on each ring, which they ſhorten by their ſimultaneous contractions: but as they do not extend the whole length of the ring, the parts which correſpond to the folds, and over which the oblique muſcles do not paſs, are elongated, while the action of the ſame muſcles diminiſhes the diameter of the ring. This facilitates progreſſion.

There is a ſecond layer with oblique fibres, under the long muſcles of the belly. They very much reſemble thoſe of the back. In conſequence

ſequence of their different directions, they may alſo be diſtinguiſhed into two kinds or orders.

Some are near the middle ventral line, along which the knotted cord of the nerves extends. In aſcending, they paſs from the inſide outwardly, in the intervals of each of the rings.

The others are not ſo oblique, except the three firſt ſuperior pairs: theſe muſcles therefore form with the preceding an angle ſimilar to this kind of *A*.

The oblique muſcles which run from within outwardly, or the moſt internal, have many fibres. They uſually conſiſt of three or four diſtinct faſciculi. Thoſe which extend from without inwardly, or the moſt external, have fewer fibres, and never more than two faſciculi.

The action of theſe muſcles appears to be ſimilar to that of the oblique muſcles of the back; but it is probable that they alſo extend immediately the ſkin of the feet on which they are ſituated.

Beſides the longitudinal and oblique muſcles of the back and the belly, caterpillars have ſome which are lateral; that is to ſay, muſcles ſituated below and above the *ſtigmata* or apertures, which ought to be deſcribed ſeparately. Theſe muſcles are of three kinds, the *ſtraight*, the *tranſverſe*, and the *oblique*.

The ſtraight lateral muſcles are ſituated between the annular ſegments, above the ſtigmata. They are all placed longitudinally one over the other. Their points of attachment are covered by the tranſverſe muſcles. They ſeem intended to bend the body towards the ſides when they act ſeparately; but when they contract in concert with the long muſcles of the back and the abdomen, they ſhorten the body, and thereby aſſiſt its progreſſion.

The tranſverſe lateral muſcles are of two kinds: ſome, which are longer than the others, ariſe from the intervals unoccupied by the attachments of the ſtraight lateral muſcles, and are inſerted at the termination of the oblique external muſcles of the abdomen. Their fibres are diſpoſed ſomewhat in the form of a fan. The others have the faſciculi formed of parallel fibres; they are ſhorter, and are extended in each of the rings between the ſtraight, lateral, and oblique muſcles of the abdomen. Theſe muſcles diminiſh the diameter of each ring, and conſequently lengthen it in each of its folds. This mode of action is neceſſary for progreſſion.

The oblique lateral muſcles are ſituated on each ſide of the ſtraight. They proceed in an oblique direction from below upward, under the inſertion of the ſtraight lateral muſcles, which they aſſiſt when they act together.

Such are the muſcles of the body in general; but the true and falſe feet, and the head, have particular muſcles, which muſt be deſcribed ſeparately.

The muſcles of the true or ſcaly feet are ſituated within the three articulations of which theſe feet are formed. They may be diſtinguiſhed into thoſe which move the articulations, and thoſe which act on the *unguis* or claw that terminates them.

The muſcles of the firſt joint conſiſt of five or ſix faſciculi, which ariſe from the ſuperior margin of this articulation, and are inſerted into the ſuperior margin of the next. The muſcles of the ſecond joint are nearly equal in number, and are inſerted into the ſuperior margin of the third.

The muſcles of the unguis terminate by two tendons; but they are formed of ſeveral faſciculi, ſome of which ariſe from the ſecond and third joints in two very diſtinct layers; others from a line which correſponds with the convexity of the unguis; and laſtly, others from the line which anſwers to its concavity. Theſe tendons are inſerted into two tubercles at the ſuperior extremity of the unguis, on the concave ſide, towards its point. They ſerve to bend the unguis, which probably recovers its poſition by the elaſticity of its articulation.

There are two muſcles to each of the membraneous or falſe feet. Their direction with reſpect to the body is almoſt tranſverſe. They extend from the centre of the feet, into which they are inſerted towards the back, and beyond the ſtigmata, whence they ariſe by lateral bands more or leſs oblique.

Their uſe is to draw the centre of the foot inwardly, and to retract the hooks with which the limb is armed.

It is probable that the contractions of the oblique muſcles of the abdomen produce the oppoſite effect.

With reſpect to the muſcles of the head, we ſhall at preſent deſcribe only thoſe which produce its entire motion. We ſhall notice the others in treating of the different functions to which they are ſubſervient.

The muſcles which act on the head, bend it upward, downward, and towards the ſides.

Thoſe which bend it upward are very numerous. They ariſe from the ſecond and firſt ring, and are inſerted into different points of the occiput; ſome near the middle line, others more laterally. They form in general two faſciculi. The moſt internal is the leaſt bulky.

The lateral flexors are very oblique. They ariſe from the inferior or abdominal part of the body, and extend to the lateral parts of the occiput.

The inferior flexors, which bend it downward, appear to be the continuation of the ſtraight muſcles of the belly. They conſiſt of eight or nine faſciculi.

2. *Muſcles of the Larva of a Scarabæus.*

The larvæ of the ſcarabæus have the body arched, and convex ſuperiorly, and concave on the ſide next the feet. The back and the belly are ſeparated by a membraneous border, which has folds, and is ſituated under the ſtigmata. Theſe larvæ have only ſix articulated feet, none of which are membraneous.

On opening theſe larvæ longitudinally, either on the back or the belly, we obſerve three very deep layers of muſcles—the lateral, the dorſal, and the ventral.

The dorſal layer is formed of two ſeries of very diſtant fibres. One ſeries is external, and occupies the intervals of the ten firſt rings; that is to ſay, thoſe which are furniſhed with the ſtigmata. The muſcles which compoſe this ſeries are narrow, and preſerve a longitudinal direction. The ſecond ſeries is produced by fibres which are ſomewhat oblique, and extended in the ſame ſpace, but more towards the middle line. Theſe muſcles are broader and ſtronger towards the head, and more narrow and leſs fibrous towards the tail. They terminate between the tenth and eleventh ring by a very narrow fleſhy band.

Theſe muſcles ſeem intended to ſhorten the dorſal portion of each of the rings: this action diminiſhes the convexity of that part, and thereby ſerves to aſſiſt progreſſion.

Near the middle line, between the ninth and tenth ring, there are two ſmall muſcles a little oblique; but between the twelfth and the laſt ring we obſerve only one ſeries of ſmall ſhort muſcles, which occupy all the convexity deſcribed by the curvature. The action of theſe muſcles is obviouſly the ſame as that of the preceding, to which they are acceſſories.

When the firſt layer of dorſal muſcles is removed, we find fibres preciſely ſimilar underneath, but running in the oppoſite direction.

Finally we obſerve, in the dorſal layer, lines of very ſhort muſcular fibres above the inferior plane of the ninth and tenth ring. The uſe of theſe little muſcles is probably the ſame as that of all the preceding, though their action is leſs apparent.

The ventral layer very much reſembles that of the back. Theſe muſcles, like the dorſal, form planes of oppoſite directions; the moſt deep-ſeated proceeding from the internal ſide, while thoſe which are neareſt the ſkin aſcend from the external ſide. This produces a ſmall but very regular rhomboidal figure in the middle of each ring on the line biſecting the belly.

The action of theſe muſcles is the oppoſite of that of the dorſal layer.

On the laſt ſegment, and towards the part that anſwers to the anus, we obſerve a bundle of tranſverſe fibres, which, by their contraction, doubtleſs ſerve the purpoſe of a ſphincter.

The lateral layer of muſcles is compoſed of three kinds of fibres, which are very diſtinct with reſpect to their courſe. They repreſent a lace paſſed through the meſhes of a net. All theſe muſcles are ſituated behind the ſtigmata, and inſerted into the folds which ſeparate the belly from the back on both ſides.

Thoſe of the firſt order are completely tranſverſe. They extend over the union of each ring with the ſucceeding in the ſpace included between the ventral and dorſal muſcles. It is obvious that they muſt diminiſh, by their contractions, the diameter of the body, and conſequently extend it longitudinally. Theſe muſcles are in general very narrow.

The ſecond ſet is formed by oblique fibres which aſcend from without inwardly towards the middle ventral line, from the union of one inferior ring to the union of the preceding. Theſe muſcles are broad and very ſtrong, they ſerve to form the folds of ſeparation between the back and the belly.

The muſcles of the third order are leſs oblique than the preceding, to which they appear to be acceſſories. Each of the muſcles which compoſe this diviſion ariſes from the middle of a ring, and is inſerted under the head, where the preceding muſcles are inſerted, that is to ſay, on the ventral ſide.

It ſhould be remarked, that the two laſt rings have no lateral muſcles.

The muſcles of the head are very ſtrong, the flexors are attached to the ventral muſcles above the union of the ſecond ring with the third. They are formed of three principal faſciculi, which approach each other and are inſerted into the poſterior and inferior part of the head, at the baſe of that ſcaly piece called, by Latrielle, *ganache**.

The extenſors or levators of the head conſiſt alſo of three faſciculi, but they are longer and ſtronger than the former. They have their origin in the ſide, and penetrate under the tranſverſe and oblique muſcles: one is attached to the ſixth ring; another to the fifth, and another to the fourth. They are inſerted into the poſterior lateral parts of the head.

3. *Muſcles of the Larva of a Hydrophilus.*

The larvæ of the hydrophili are elongated. Their body is ſomewhat flat, and all its rings are diſtinct. They not only walk very quick, but they even ſwim with great velocity, in conſequence of different inclinations ſuddenly and ſucceſſively given to the body.

Theſe larvæ, when opened longitudinally, likewiſe exhibit four different kinds or diviſions of muſcles. Thoſe of the belly, thoſe of the back, and thoſe of both ſides.

The ventral muſcles very much reſemble thoſe of caterpillars: They are formed of two diſtinct layers. The deepeſt, or that which firſt appears on the belly when examined through an opening on the back, is compoſed of longitudinal fibres with interſections which correſpond to each

ſkin

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* See—*Tableau Elementaire de l'Histoire Naturelle des Animaux, par* CUVIER. Livre 7, Chap. 5.

ring: the ſecond layer, or that which is next the ſkin, is entirely covered by the preceding; it is compoſed of oblique fibres, which croſs each other in the form of an X, and which are extended longitudinally in each ring.

The dorſal muſcles are long, extending from the head to the tail, and forming on each ſide two rows of fibres, which appear twiſted over each other like ropes. They are broadeſt towards the head. Their fibres are inſerted partly into the inferior border of an anterior ring, and partly into the ſuperior border of the next ring.

Theſe long muſcles cover ſome which are oblique, and croſs each other in the form of an X. They extend from the middle part of one ring to the anterior edge of that which ſucceeds it.

The deep ſeated lateral muſcles, which are numerous, have a tranſverſe direction. Each ring has three or four, and their courſe is ſuch, that they reſemble the letters N or M lying on one ſide, thus Σ Z

Beneath the tranſverſe lateral there are ſome longitudinal muſcles that have a ſmall degree of obliquity: they form a pretty large ſurface, which is uninterrupted throughout its whole length, and confounded with the oblique muſcles of the belly. Their fibres determine the chief motions of the body, in the ſame manner as the long muſcles of the back and belly.

The muſcles of the feet are the ſame as in the perfect inſect.

The head has no particular muſcles. The long muſcles of the back, being inſerted into the occiput, become extenſors. The firſt tranſverſe lateral pair are inſerted beneath the head, and produce the lateral flexion. The long oblique muſcles, which terminate at the inferior part of the head, become real flexors.

4. *Muſcles of the Larva of a Cerambix.*

In the larvæ of the *cerambices* we find the ſame muſcles as in thoſe of the *ſcarabæi*; but as the ſhape of the body differs conſiderably in theſe two kinds of larvæ, there reſults ſome variation in the form and extent of the muſcular organs.

A great part of the head of the larva of the cerambices can be drawn within the ſkin whenever the animal pleaſes. Very ſtrong muſcles, ſimilar to thoſe we have deſcribed in the ſcarabæus, are appropriated to this function. As the head, which is very large, enters into the body, the extremity which receives it is ſomewhat thicker than the ſame part of the ſcarabæi, and the muſcles which move the rings are more extenſive than theirs.

The flat fleſhy tubercles which we find continued along the back and the belly, are a kind of feet, which this larva uſes in progreſſion. They move by the alternate contractions of the correſpondent muſcles: this larva, therefore, moves with equal facility on the back and on the belly.

ARTICLE VI.

Of the Organs of Motion in Perfect Inſects.

THE great variety of motions which inſects are capable of performing, entitles them to hold the firſt rank among the animals that have no vertebræ. We diſcover, in theſe minute beings, all the requiſites neceſſary to produce thoſe voluntary actions, the execution of which aſtoniſhes us in vertebral animals of far greater magnitude. They even unite ſeveral functions which are very ſeldom found combined in the other claſſes; for inſects walk, run, leap, ſwim, and fly with as much facility as the mammalia, birds and fiſhes, exerciſe one or more of theſe faculties.

Inſects are probably indebted for this advantage to the numerous articulations of which their bodies are formed. We muſt therefore pay attention to their different articulations, before we proceed to examine the actions they permit or produce.

The bodies of inſects may, in general, be divided into the *head*, the *corſelet*, the *pectus*, the *abdomen*, and the *members*. There are ſome genera, however, as the *ſcorpions*, the *phalangium*, and *ſpiders*, in which the head is not ſeparate from the corſelet. Other Aptera, as the *julus*, *ſcolopendra*, *ticks*, *mites*, *fleas*, &c. have the corſelet and the abdomen confounded together. Laſtly, there are ſome inſects which have the abdomen prolonged into a moveable tail, allotted to particular functions: ſuch are the *ſcorpions* and the *panorpæ*.

We ſhall now conſider the different articulations of all theſe parts, independent of their external forms, the deſcription of which comes more properly within the province of what is ſtrictly called Natural Hiſtory.

I. *Of the Head.*

The articulation of the head of inſects with the thorax preſents two general diſpoſitions. In the one, the points of contact are ſolid, and the motion depends upon the ſhape of the parts: in the other, the articulation is ligamentous; and the head and the thorax are united and held together by membranes.

The articulation of the head, by the contact of ſolid parts, takes place in four different ways.

In the moſt common conformation, the head has, at the part anſwering to the neck, one or two ſmooth tubercles, which are received into correſpondent cavities on the anterior part of the corſelet. This is obſervable in the *ſcarabæus*, the *lucanus*, the *cerambix*, and a great number of Coleoptera: In this firſt caſe the head is moveable forward or backward, and the mouth is directed forward and downward.

The ſecond mode of ſolid articulation takes place when the poſterior part of the head is rounded, and turns on its axis in a correſpondent ſocket on the anterior part of the thorax. Examples of this conformation are to be found in the *weevils*, the *attelabus*, the *brentus*, the *reduvius*, &c. The axis of motion is then in the centre of the joint, and the mouth of the inſect can be directed either forward and backward, upward and downward, or to right and left.

The third ſort of articulation, by ſolid ſurfaces, occurs when the head is truncated poſteriorly, and articulates by a flat ſurface, either to a tubercle of the thorax, or to another flat and correſponding ſurface; as is the caſe in almoſt all the Hymenoptera, and in the greater number of the Diptera, ſuch as *flies*, *ſyrphus*, *ſtratyomis*, *aſilus*, &c.

The fourth ſpecies of articulation allows to the head only the ſingle motion of an angular hinge. We know as yet of no examples of this kind, except in ſome ſpecies of the *genus attelabus of Fabricius*. The head of theſe inſects terminates poſteriorly by a round tubercle, which is received into a correſpondent cavity of the thorax: the inferior edge of this cavity is notched, and confines the motion of the head to one direction.

The ligamentous articulation is found only in the Orthoptera order of inſects, and in ſome of the Neuroptera: In this mode of articulation the head is not confined in its motion, except towards the back. In that direction it is oppoſed by a projection of the thorax, but inferiorly it is perfectly free. The membranes or ligaments extend from the circumference of the occipital foramen to that of the anterior part of the corſelet: This admits a very extenſive motion.

The muſcles which move the head are ſituated within the thorax. We ſhall deſcribe here only thoſe moſt generally met with. The *levators* or *extenſors* of the head are commonly ſituated in the ſuperior part of the corſelet, and the *depreſſors* inferiorly.

Immediately beneath the middle dorſal part of the corſelet, we find a pair of muſcles which ariſe from the anterior portion of the ſcutellum, when that part exiſts; or from the ſuperior part of the pectus. Theſe muſcles are inſerted into the poſterior and ſuperior part of the head, on the edge of the occipital hole: they draw the head back, and lift it up when it is depreſſed.

On the lateral parts of this firſt pair we find another which is more ſlender: The inſertion of this pair likewiſe takes place at the occipital hole, but more outwardly. They ariſe obliquely from the lateral parts of the corſelet. Theſe muſcles turn the head to one ſide when they act ſeparately; they raiſe it, and bring the mouth into the middle line when they contract together. It will be eaſily conceived that in inſects which have the head articulated like a knee, theſe rotatory muſcles are much ſtronger, and more conſpicuous.

The flexors of the head are alſo four in number, two on each ſide.

The firſt pair ariſes in the internal inferior part of the pectus, from a ſmall horny proceſs, which, in the Coleoptera is of a ſquare form, and has the four angles terminated by ſolid branches. Theſe muſcles extend directly to the inferior part of the occipital hole. From their poſition they doubtleſs move the head directly backward.

The ſecond pair, which are much ſhorter, ariſe from the inferior lateral part of the corſelet, and proceed to the ſide of the preceding, with which they concur in their effect when they act together; but when one of the two contracts ſeparately, it bends the head to ſide.

II. *Of the Corſelet or Thorax.*

The thorax or corſelet of inſects is ſituated between the pectus and the head. The firſt pair of feet are joined to this part, and it contains the muſcles for moving their firſt articulations, and the head. The corſelet is remarkable for its ſmall extent in the Hymenoptera. There is often no part of it to be ſeen on the back. In the *chryſis*, however, it forms an articulation before the pectus, which may be very eaſily diſtinguiſhed.

There is another peculiarity in the conformation of the corſelet, which gives to the *elater* the faculty of leaping: two poſterior and lateral points prevent it from being thrown too far back, while inferiorly there is a ſingle bent ſpine which the animal inſerts with a ſpring into a foſſa of the pectus.

III. *Of the Pectus or Breaſt.*

The pectus is the third articulation of the body of inſects. The wings in thoſe that have them, are attached to it ſuperiorly, and the four poſterior feet inferiorly: the dorſal ſurface of this part is frequently furniſhed with a horny proceſs or appendix, the figure of which is various, and which is called the *ſcutellum* or *eſcutcheon*; the ſituation of this appendix between the wings appears to indicate that it ſerves as a point of ſupport to theſe members in flight. It is wanting however in the Lepidoptera.

There is alſo inferiorly, in the middle line between the coxæ, a longitudinal ridge, which is called the *ſternum*, and which is more or leſs elevated in different genera. It is very remarkable in the *bupreſtis*, the *dytiſcus*, and the *hydrophilus*.

The breaſt contains the muſcles that move the wings and the four poſterior feet, as will be ſeen when we treat of the members. It alſo appears that this part is capable of being compreſſed and dilated, at leaſt we find within it ſome very ſtrong muſcles which ſeem to approximate the dorſal and ventral ſurfaces: they may indeed aſſiſt in the general movement of the wings, but this we have not yet been able to determine with preciſion. They are, however, four in number on each ſide, and differ very much in their colour and texture from the other muſcles; for they are of a reddiſh yellow hue, and their texture is extremely looſe.

IV. *Of the Abdomen or Belly.*

The abdomen of inſects is the fourth and laſt diviſion of the trunk. It commonly conſiſts of ſeveral rings, the number of which is very variable: ſometimes it is *ſeſſile*, that is to ſay, ſituated ſo cloſe to the pectus that it ſeems to be a continuation of it; as in moſt of the Coleoptera, *tenthredo*, *sirex*, *ſcorpions*, *&c.* Sometimes it is *petiolated*, that is to ſay, there is a very conſpicuous contraction between the pectus and the abdomen, as in *waſps*, in the greater number of Hymenoptera; ſome Diptera, *ſpiders*, *&c.* Sometimes the abdomen is terminated by a *ſting*, *briſtles*, *plates*, *points*, *hairs*, *long threads*, *&c.* but it belongs to the Naturaliſt to deſcribe theſe peculiarities. We muſt confine ourſelves to the conſideration of the motions of the abdomen: theſe are of two kinds, one total, and another partial.

The total movement of the abdomen is not very obvious, except in the inſects which have that portion of the body pediculated: It has then a real joint, a kind of hinge, in which the firſt ring is indented ſuperiorly, and receives a projecting proceſs of the pectus, on which it moves. This articulation is rendered ſecure by elaſtic ligaments, which have a conſiderable degree of force. Some muſcles which ariſe within the pectus, are inſerted into the firſt ring, and determine the extent of its motions.

With reſpect to the inſects in which the abdomen is ſeſſile, the muſcles that move the firſt piece are the ſame as thoſe that act from one ring to another.

The partial motion of the rings is produced by very ſimple muſcles: they conſiſt of fibres which extend from the anterior edge of one ring to the poſterior edge of that which immediately precedes it. When the dorſal fibres contract, the ſuperior part of the abdomen being ſhortened, it turns up towards the back; but when the contraction takes place in the ventral or lateral fibres, the abdomen is inflected towards the belly, or directed towards one of the ſides. The extent of the motion, however, depends upon the number of the rings, and the mode of their junction. In the Coleoptera, for example, the rings only touch each other by their edges, and the motion is very limited; but in the Hymenoptera they are ſo many ſmall hoops which are incaſed into one another like the tubes of a teleſcope, and often only one-third of their extent appears externally.

Such are all the motions that belong to the abdomen of perfect inſects.

V. *Of the Members.*

The organization of the members remains ſtill to be conſidered. We ſhall begin with the feet, and deſcribe in ſucceſſion their *number*, their *general form*, their *ſtructure*, their *reſpective proportion*, and their *motions.*

The *number* of the feet varies. There is never more nor leſs than ſix in the winged inſects; but the number is very unequal in thoſe that have no wings: *lice, fleas, podura, lepiſma* and *mites*, have ſix attached in the ſame manner as thoſe of winged inſects: *ſcorpions, ſpiders*, and the *phalangium* have eight, the *oniſcus, julus* and *ſcolopendra*, have them attached to all the rings of the body, the head and tail excepted. In ſome we find two pair to each ring, and in others only one pair.

The *general form* of the feet of inſects depend upon their mode of life. Thoſe that inhabit water, and ſwim, have their feet flat, long and ciliated: In thoſe that employ them in digging the earth, they are broad, ſerrated and ſharp-edged; if uſed in walking only, they are long and cylindrical; when they are calculated for leaping, the femur is thick, the tibia long, and frequently arched. From theſe different conformations it is very eaſy to recognize the habits and mode of living even of the dead inſect.

The feet of inſects are *compoſed* of four principal parts, which are denominated the *haunch* or *coxa*, the *thigh* or *femur*, the *leg* or *tibia*, the *toe* or *tarſus*.

Each of theſe parts is enveloped in a caſe of a horny ſubſtance. They move on one another by ginglymus, becauſe the hard ſubſtance being external, the articulation cannot take place by leſs than two tubercles. The motion of each joint is therefore performed in a ſingle plane, that of the coxa excepted, as we ſhall preſently ſee.

The *coxa* joins the member to the body, and moves in a correſponding cavity of the corſelet, or the pectus, without being articulated in a poſitive manner, but as it were incaſed. The form of the coxa varies. The inſects in which the feet ſerve for walking only, as the *cerambix*, the *chryſomela*, the greater number of the Hymenoptera, Diptera, &c. have the coxa globular, and forming a real mechanical knee: but thoſe in which it is neceſſary the feet ſhould poſſeſs that lateral motion which is requiſite in ſwimming, removing the earth, &c. have the coxa broad and flat, and, in general, its longeſt diameter in the tranſverſe direction of the body. There are even ſome, as the *dytiſcus*, or *water beetles*, in which the poſterior coxa is conſolidated with the trunk, and immoveable. It is compreſſed into the form of a plate in the *blatta*, the *lepiſma*, and ſome other genera which walk very rapidly.

The *femur* immediately follows the coxa, to the internal part of which it is articulated, in ſuch a manner that, when the animal is in a ſtate of repoſe, it is parallel to the inferior ſurface of the body. It is limited to a forward and backward motion, with reſpect to the firſt piece. The nature and extent of the motions of the femur appear to determine its form. In the inſects that walk much, and fly little, as the *carabus*, the *cicindila*, *&c.* the femur has one or two eminences, called trochanters, at its baſe. Theſe appear to be intended for removing the muſcles from the axis of the articulation. Thoſe that require ſtrong muſcles, ſuited to leaping, have the thigh thick, and frequently elongated, as in the *graſs-hopper*, *altica*, ſome *weevils*, *fleas*, *&c.* In thoſe that dig the earth, the femur, which is moved with much force, has an articular ſurface correſponding to the flat part of the coxa, on which it reſts. This is obſervable in the anterior feet of ſome *ſcarabæi*, *ſcarites*, *mole-crickets*, *&c.* In fine, the form of the femur is always ſubordinate to the kind of motion it has to perform.

The *tibia* is the third joint of the limb. It moves in an angle, with reſpect to the femur, and is not ſuſceptible of any other direction. The figure of the tibia depends eſſentially on the uſes to which it is applied: this may be remarked in the ſwimming inſects, which have it flat and ciliated; and in thoſe that dig the earth, which have it ſerrated and ſharp-edged. In the *nepa*, *mantis*, and ſeveral others, the anterior foot is terminated by an unguis, and forms with the femur a kind of forceps, which theſe inſects employ to retain their prey while they devour it living.

The *tarſus* or *toe* of inſects forms the laſt portion of the foot. It conſiſts, in general, of ſeveral joints, the laſt of which is terminated by one or two hooked ungues, or claws. Theſe joints move upon each other, and ſometimes they are capable of being oppoſed to the tibia, and thus form a kind of pincers: The figure of the tarſus is always conformable to the inſect's mode of life. The articulations are ſlender, ſcarcely diſtinct, and deſtitute of tufts, or balls, in the great number that burrow in the earth, and ſeldom walk on its ſurface, as the *ſcarabæus*, *hiſter*, *ſpheridium*, *ſcaritis*, the *ſavages*, *&c.* They are flat like fins, ciliated on the edges, and often deſtitute of claws in the inſects that ſwim, as the *hydrophilus*, *water-fleas*, the *naucoris*, *ſigara*, *&c.* They are furniſhed with viſcous balls, briſtly tufts, or vaſcular fleſhy tubercles, in thoſe that move upon ſmooth and ſlippery bodies, as *flies*, *chryſomelæ*, *cerambices*, *thripes*, *&c.* They are formed into two moveable and oppoſable claws, in inſects that crawl along hairs, and hook themſelves to them, as common *lice*, *ricini*, and *mites*. In the males of ſome ſpecies of the *genus crabro*, and ſome *dytiſci*, one of the articulations is very much enlarged, and covered with hairs diſpoſed in parallel lines.

The tarſus is terminated by a ſingle claw in ſome *may beetles*, the *water-ſcorpion*, *&c*; by two in the greater number of inſects; and by two and an appendix forked in the middle, in the *ſtag beetles*.

There is a particular variation with reſpect to the number of joints which compoſe the tarſus. In moſt of the Coleoptera, and in all the Hymenoptera and Diptera, it conſiſts of five articulated portions; in the genera *curculio*, *chryſomela*, *cerambix*, and *gryllus*, of four; in the *dragon-flies* and *ear-wigs*, of three; in the anterior feet of the *mantis*, *nepa*, and *naucoris*, of one only; the anterior feet of the *papiliones nymphales* have none.

The *relative proportion* of the feet determines in a certain degree the manner of each inſect's motion in walking: for example, when the legs are all equal, the movement is uniform, but its rapidity varies according to their length. The ſpecies therefore which have long legs run very quickly: this is obſervable in the *phalangium*, *ſpider*, *ſcolopendra*, *aſilus*, *rhagio*, *cerambix*, *molorchus*, *cicindela*, *carabus*, *&c*. On the contrary, thoſe that have ſhort

legs

legs are remarkable for a very ſlow pace: of this kind are the *julus*, *ticks*, *gall inſects*, &c.

When the anterior feet are longeſt, they retard motion: this takes place in the *ephemera*, the *mantis*, the *nepa*, *ranatra*, and in ſome of the *ſcarabæi*, the *cerambix*, *clytra*, &c. Feet of this kind, therefore, are of little uſe to the inſect that is provided with them, except in enabling it to lay hold of bodies to hook itſelf to them.

When the poſterior feet are longeſt, they give to the inſect the faculty of leaping. This effect may be remarked in the *graſs-hoppers*, *crickets*, *fleas*, &c. There are, however, ſome inſects diſtinguiſhed for leaping, in which the poſterior legs are not longer than the others, but they poſſeſs this faculty in conſequence of their thighs being very thick, and furniſhed with particular muſcles. Such are the *altica*, *cicada*, ſome *weevels*, and ſome *ichneumons*.

Laſtly, there are ſome inſects which do not leap, though the poſterior legs are longeſt, and the thighs very thick. Among theſe are ſome of the *bruchi* of Fabricius, the *boria*, *œdemera*, *leucoſpis*, *chalcis*, &c. but all theſe inſects have a great curvature in the legs.

We may now examine the *organs of motion in the feet*. The motion of each joint is performed in a ſingle plane. It is provided by only two muſcles, which are enveloped in the preceding joint. Theſe are an extenſor and a flexor.

In the Coleoptera the coxæ move by a kind of rotation on their longitudinal axis, which, as we have already obſerved, is ſituated tranſverſely, and forms, with the middle line of the body, an angle more or leſs approaching 90°. As the femur is attached to the internal extremity of the coxa, the diſtance between the thighs is greateſt in thoſe inſects in which the femur is moſt bent with reſpect to the coxa, to which it is articulated. It is obvious, therefore, that the poſition of the plane in which this flexion is made, depends upon the ſituation of the coxa: when it is turned forward, the plane is vertical; when turned backward, the plane is always more oblique; and in the inſects that ſwim, it is even horizontal. It appears then that the almoſt imperceptible motion of the coxa determines the moſt remarkable movements of the feet.

The muſcles of each pair of coxæ and femora are ſituated in the ſuperior part of the corſelet or of the pectus. To obtain a proper view of them, it is neceſſary to cut the body of the inſect in a vertical direction.

Over the laſt pair in the pectus there is a ſcaly ſubſtance, in the form of a Y. The ſtalk of this part affords an origin to a muſcle which turns the coxa backward, and is inſerted into its poſterior edge. The muſcle which turns it forward ariſes from the back, and is inſerted by a thin tendon into its anterior edge.

The muſcle which extends one femur, while it is approximated towards the other, is very conſiderable.

ſiderable. It ariſes from the whole branch of the piece, in the form of a Y, and is inſerted into the internal edge of the head of the femur. Its antagoniſt is ſituated within the body of the coxa.

The muſcles which extend the two pairs of anterior femora, ariſe from the correſponding dorſal parts, and not from particular internal ſubſtances: the flexors, however, are always ſituated within the body of the coxæ.

The muſcles which turn the femora ariſe alſo from the parietes of the corſelet, viz. the muſcle which moves it backward to the dorſal part, and that which moves it forward to the lateral part. In the *water beetles*, which, as we have obſerved, have the poſterior coxa conſolidated and immoveable, theſe muſcles ſeem to extend to the femur, which is therefore furniſhed with four, two extenſors and two flexors.

The other orders of inſects have nearly the ſame conformation as the Coleoptera.

The muſcles of the tibia are ſituated within the femur. The extenſor, which is ſhort and ſlender, is attached to its external edge, (the femur being ſuppoſed extended in the longitudinal direction of the body:) the flexor is much ſtronger and longer. It is ſituated on the inner ſide, and in the whole of the ſuperior part.

There are likewiſe two muſcles to each joint of the tarſus: one, which is ſmall, and placed on the ſuperior or dorſal ſurface, acts as an extenſor.

tenſor. The other, which is more conſpicuous, and ſituated on the inferior ſide, acts as a flexor.

The wings, as we have already remarked, are members attached to the lateral parts of the pectus. They are particularly appropriated to flight. One entire order of inſects, the Aptera, is deprived of them; another order, the Diptera, has only two; but the greater number have four. In the latter, however, there is much variety in the texture of the wings. In the Hymenoptera and the Neuroptera the four wings are entirely membranous. Thoſe of the Lepidoptera are covered with farinaceous ſcales of different colours. In the Coleoptera the two ſuperior wings are horny caſes, more or leſs ſolid, called *elytra*. They completely cover the two inferior wings, which are membranous, and fold upon each other, forming a doubling at their external edge. In the Orthoptera the ſuperior wings conſiſt of elytra or ſemimembranous caſes. They cover the inferior wings, which fold longitudinally, without any tranſverſe doubling, the genus *forficula* excepted. Laſtly, in the Hemiptera the inferior wings fold croſſways under elytra, which are partly coriaceous, and partly membranous.

In the Diptera order, there is under each wing the rudiment of another, which terminates in a little button or ſmall ſolid head. Theſe parts are called *halteres* or *balancers*, becauſe it is ſuppoſed they ſerve to maintain the equilibrium of the inſect's body during the rapid motion of its wings: this much at leaſt is known with certainty, that every time the inſect ſtrikes the air with its wings, a very quick motion is perceived in the balancers. There is alſo found in the Diptera, between the balancer and the wing, a hollow membranous ſcale, reſembling a ſpoon without a handle. When the balancer moves, it ſtrikes againſt this part, and appears in that manner to produce the well-known buzzing ſound made by flies when they are on the wing.

The muſcles that move the wings are not yet well aſcertained. They appear to be two kinds. Some, which are ſmall and ſhort, are fitted to extend or fold the wings, at the ſame time that they move them to or from the body: the others, which are ſomewhat longer, are calculated to produce the motions of elevation and depreſſion which the wings perform.

The elytra of the Coleoptera, Orthoptera, and Hemiptera, do not appear to aſſiſt in the action of flying, at leaſt they are not moved in the ſame manner by the muſcles of the pectus.

The manner in which the wings are folded or plaited merits ſome conſideration. Citizen Jurine, of Geneva, has made ſome very curious obſervations on the appearance of the nervous lines and diviſions of the ſuperior wings in the Hymenoptera: he has ſhewn that theſe appearances are highly characteriſtic, and has founded ſome very natural genera upon them. This method, applied to the other orders, would perhaps afford reſults equally ſatisfactory. The genus *cicindela*, for example, has a kind of tranſparent diſk at the corner of the wing. The wings of the *forficula* are folded three times tranſverſely, and afterwards plaited throughout their whole length, &c.

We ſhall here cloſe our examination of the organs of motion in perfect inſects.

Article VII.

Of the Organs of Motion in Worms.

The organs of motion in worms are not ſo perfect as in caterpillars. Having neither ſcaly nor membranous feet, ſeveral of them crawl or drag themſelves along by the help of ſtiff hairs or briſtles, with which they are wholly or partly covered: of this deſcription are the genera *aphrodita*, *terebella*, *nereis*, *lumbricus*, &c. Two kinds of muſcles contribute to their motion.

The one extends the whole length of the body, and forms four principal faſciculi, two of which belong to the belly, and two to the back. Theſe four muſcles may be ſaid to conſtitute the maſs of the body. We find them immediately below the ſkin. Their fibres are parallel; but their length does not exceed that of the rings, being interrupted in the folds of each ring by a very compact cellular tiſſue. The ſtructure of theſe muſcles is, however, moſt diſtinctly obſerved on the inſide. We there find that they are ſeparated from each other by a longitudinal line, and enveloped in a kind of ſack, of a cloſe cellular ſubſtance, which correſponds to each ring of the body. Theſe four muſcles produce the principal motions. When thoſe of the back contract wholly or partially, they raiſe the portion of the body to which they belong: the ſame effect, but in the oppoſite direction, is produced by the contraction of the ventral muſcles.

The ſecond order of muſcles in worms is particularly appropriated to the motion of the ſpines or briſtles. Their number is equal to that of the tufts of hairs. The deſcription of one of them will be ſufficient to give us a knowledge of the whole.

The hairs, briſtles, ſpines, tubercles, &c. which project more or leſs from the ſurface of the bodies of theſe animals, are manifeſtly moveable. They are retracted and puſhed out at pleaſure. The muſcles which produce theſe motions are viſible only when the animal is laid open, the inteſtinal canal taken out, and the ſkin ſtripped off. We then obſerve that each tuft of hairs is received in the concavity of a fleſhy cone, the baſe of which is attached to the longitudinal muſcles, and the apex to the internal extremity of the hairs. All the fibres which form this cone are longitudinal, but enveloped by a compact cellular ſubſtance. They move the hairs outwardly, and in the direction which their contraction may determine. This firſt claſs of the muſcles, which belong to each bunch of hairs, may be called the *protractors of the ſpines*.

The motion by which the ſpines are drawn within the body, is produced by another ſet of muſcles, which may be called *retractors*. They have fewer fibres than the former; their action is therefore very feeble. They are ſituated under the internal ſurface of the long muſcles, at a ſhort diſtance from the holes with which the latter are perforated for the paſſage of the hairs. They are inſerted into the tufts of ſpines, nearly on a level with the point which theſe reach when completely retracted. It may be conceived that the protractors, when they act, puſh the retractor outward; but the latter, when contracting in its turn, tends to recover the parallel ſituation of its fibres, and thus draws the ſpines inward.

It is by the help of thoſe muſcles, and the ſpines on which they act, that the imperfect locomotion of theſe worms is effected.

There is another family of worms which want both ſpines and briſtles, and have therefore a different muſcular organization. Their manner of crawling varies conſiderably from that of the former.

Their progreſſion is accompliſhed by the help of the two extremities of their bodies, which they apply alternately to the ſurface on which they crawl. They are fitted for this kind of motion by a peculiar ſtructure. We may divide them into two orders.

The firſt, as the *leeches*, and ſeveral *inteſtinal worms*, have the head and the tail terminated by a kind of contractile fleſhy diſcus, ſomewhat reſembling thoſe of the *cuttle fiſh*. The ſtructure of theſe two diſks, which perform the office of ſuckers, cannot be eaſily aſcertained, for when the ſkin which covers them is removed, we obſerve only ſome very ſmall fibres interwoven in different directions.

Though the worms with ſuckers poſſeſs a great power of contraction, it is extremely difficult to trace the muſcles that move their bodies. Their whole ſkin may indeed be regarded as one muſcle, or a kind of fleſhy ſack, furniſhed with circular and longitudinal fibres, and containing the veſſels, viſcera, and glands. This muſcular ſkin is thick, and lined with a very ſolid and compact cellular ſubſtance.

When the worm wiſhes to change its place, the body is fixed at one of the extremities by the means of the ſucker that terminates it; the circular muſcles of the ſkin then ſeparately act, which elongates the animal's body by diminiſhing its diameter: when the free extremity has in this manner reached the place to which the worm chooſes it ſhould be extended, it is applied and made faſt to that ſpot by the ſucker, and becomes the fixed point of a new motion: the animal having removed the ſucker firſt made uſe of, draws it by the operation of the longitudinal fibres of the ſkin, towards the ſecond ſucker, and proceeds in this manner to fix each extremity alternately. This is the mechaniſm by which progreſſion is effected in the worms that have terminating diſks.

The ſecond order of worms which move by fixing their extremities, comprizes the greater part of the *vermes inteſtina*. Theſe poſſeſs a leſs degree of contractile power than the *leeches*, and their motions are therefore leſs extenſive. Their head, inſtead of being terminated by a diſk, is ſometimes provided with hooks, by the means of which they faſten themſelves to the parts they ſuck. Such are the *common tænia*, the *tenia ſolium*, the *hydatigena*, the *hæruca*, the *echinorhynchus*, the *uncinaria*, &c. &c. The diſpoſition and curvature of the hooks, which vary conſiderably, have been deſcribed by Naturaliſts.

ARTICLE VIII.

Organs of Motion in Zoophytes.

THE organs of motion in the zoophyta vary conſiderably in their nature, their form, and their [illegible] action. It is therefore neceſſary to the obtaining a juſt idea of theſe organs, that we ſhould take a particular and ſucceſſive view of them in certain orders of thoſe animals. There is indeed often more difference as to form between one of the Infuſoria and one of the Echinodermata than between a reptile and a fiſh, or even between a fiſh and ſome mammalia.

In treating of the parts which contribute to the motions of zoophytes, we ſhall follow the courſe traced out to us by Naturaliſts; we muſt therefore firſt examine them in the order Echinodermata, the greater part of which is diſtinguiſhed by numerous retractile feet, and an envelope more or leſs ſolid.

Theſe retractile feet are a kind of ſuckers, and have nearly the ſame organization in the three genera which compoſe this order. Each of theſe ſuckers can be contracted ſeparately. In their form they reſemble a globular phial, or ampulla, with a long tube. They are filled with a fluid, and their parietes are formed of circular fibres. The elongated or tubular portion of the ampulla is the only part that appears without the animal when the feet are extended. It is terminated by a kind of diſk, which is concave in the middle. The ſpherical portion is ſituated within the body. From this conſtruction of the foot, the mechaniſm of its action will be eaſily underſtood.—The liquor contained in the ampulla, becomes, by a change of place, the cauſe of motion:

tion: when the foot is drawn into the body, the ſpherical portion of the ampulla is greatly enlarged: when the foot protrudes, the parietes of the ampulla contract and impel the contained fluid into the tubular part, which conſequently increaſes both in length and circumference. In the retractile motion of the foot, the tunic of the tube is contracted, and the liquor thereby forced back into the body of the ampulla.

The number and portion of theſe feet vary conſiderably, even in the ſpecies. This will be apparent from the view we are about to take of the different genera.

The *holothuria* are covered with a thick coriaceous ſkin, which the animal can lengthen or ſhorten at pleaſure. Theſe two motions are produced by longitudinal muſcular bands, which vary as to their length and breadth in different ſpecies, and ſmaller tranſverſe bands extended over the whole internal ſurface of the body. The animals included in this genus have their feet diſpoſed in different manners, and in ſome ſpecies they are even wanting. In the others we find them either ſpread irregularly over the whole body, ſituated upon one ſide only, or placed in longitudinal rows.

The *aſterias* or *ſea-ſtars* have the covering of the body of a very cloſe fibrous texture, the interſtices of which are filled with grains of calcarious matter of various forms and dimenſions. This kind of cruſtaceous ſkin is, however, ſuſceptible of a certain motion, which, though ſlow, is very remarkable. The body of the animal is commonly divided into five branches to which the feet are attached. Theſe laſt are ranged in ſeveral files throughout the whole length of the branches from the mouth. The branches are ſometimes furniſhed with ſpines, their middle portion is frequently entirely calcarious, but articulated at its origin, and moveable upon the central part of the body.

The *echinus* or *ſea-eggs* are encruſted by a complete calcarious ſkin, the ſurface of which is covered with tubercles diſpoſed in a very regular manner. Moveable ſpines of various ſhapes and ſizes are articulated to theſe tubercles. It is very difficult to diſcover the fibres by which the ſpines are moved at the will of the animal; for in their joints we obſerve only a ſolid ligamentous ſubſtance, which cannot be eaſily cut. The feet are protruded from the body of the animal through holes which perforate the ſhell with a great deal of regularity, and which form uniform and parallel lines, called by naturaliſts *ambulacra*, becauſe they have compared them to the alleys of a garden.

The organs which produce motion in the other orders of zoophyta are not more apparent. They eſcape our obſervation in conſequence of their tranſparency. A great number of them have their mouths furniſhed with tentacula, which are moveable at the will of the animal, and with which it ſeizes its prey. The *meduſa* ſwim by diſplacing the water with alternate motions, which render their bodies at the one time flat, and at the other convex. The coriaceous ſkin which covers the *actinia*, poſſeſſes ſo extraordinary a power of contraction, that theſe animals can aſſume the moſt diſſimilar forms at pleaſure. Sometimes they are flattened into a diſk, ſometimes elevated into a cone, ſometimes lengthened into a cylinder, &c. &c. In the *hydra* we find only ſome moveable tentacula. In the *vorticella* and the *rotifer*, we can obſerve, by the help of inſtruments, ſome cilia of different figures turning round their axis with aſtoniſhing rapidity.

We now cloſe our anatomical view of the organs of motion: we have not thought it neceſſary to deſcribe their external forms, becauſe that has already been done by Naturaliſts, and becauſe our object is merely the examination of their internal ſtructure.

LECTURE SEVENTH.

OF THE ORGANS OF MOTION CONSIDERED IN ACTION.

In the firſt part of this work we have deſcribed the forms, the connexions, and the relations of all the organs of motion.

Our attention has been principally directed to the articulations of each bone, and the particular action of each muſcle, and to the variations which theſe organs undergo in different animals.

We ſhall now conſider the effect which reſults from the united or ſucceſſive action of all theſe organs, in producing the general and partial motions performed by animals; and examine how far theſe effects are modified by the different organs in each family.

Article I.

Of Standing.

Standing is that poſition in which an animal ſupports itſelf firm and erect on its legs.

If a man, or any other animal, ſuddenly dies while ſtanding, or ceaſes, in conſequence of ſome other cauſe, to make the neceſſary efforts for preſerving that poſition, all the articulations of the legs yield to the weight of the body, and bend under it. Standing is then ſolely the effect of the continued action of the extenſor muſcles of all the joints; the flexors contribute nothing to it. This is one of the cauſes which renders it more fatiguing to ſtand long, than to walk during an equal time; as in walking the extenſors and the flexors act alternately.

There are, however, ſome animals in which certain articulations are maintained in a ſtate of extenſion, in conſequence of their particular form, and the ligaments attached to them. The *ſtork* affords an example of this. The ſurface of the femur that articulates with the tibia, has in its middle a depreſſion which receives a projection of the latter bone. In bending the leg, this proceſs is lifted out of the depreſſion, and removed to its poſterior edge. By this motion the ligaments are neceſſarily more ſtretched than during the extenſion of the leg, in which the proceſs remains in its ſocket. Theſe ligaments therefore preſerve the leg extended in the manner of ſome ſprings, without receiving any aſſiſtance from the muſcles.

This ſtructure enables birds of this kind to paſs whole days and nights on one foot without being fatigued.

It is not ſo with man and quadrupeds; they are preſerved in a ſtanding poſition by the action of the muſcles only: but the extenſion which that action produces is not to be regarded as a ſtate perfectly motionleſs. It rather conſiſts of very ſmall alternate flexions and extenſions.

Animals may ſtand on two, on four, or on a greater number of feet.

Thoſe which ſtand upon two feet, may have the body either vertical, or inclined towards the horizon.

A. *Standing on two feet with the body vertical.*

To retain a body in a vertical poſition, it is neceſſary that all its parts be ſo diſpoſed as to be eaſily preſerved in a ſtate of equilibrium;—that the muſcles have the power of continually correcting all motions which might produce a deviation from this balanced ſtate;—that the centre of gravity of the whole body fall within the limits of the plane occupied by the ſupports of the body, or its feet;—and finally, that theſe feet be placed firmly on the ground, and ſo formed as to accommodate themſelves to its inequalities.

Man is the only animal that poſſeſſes all theſe requiſites in the neceſſary degree.

It is obvious that the more extenſive the ſurface which the feet include, the leſs is the danger of the centre of gravity being removed beyond its boundaries. This obſervation applies peculiarly to man, whoſe feet are very broad, and who can ſeparate them to a much greater diſtance than the other animals.

The power of ſeparating the feet in man depends, 1ſt, on the width of the pelvis, which is proportionally greater than that of all the other animals, who, in other reſpects, poſſeſs ſome of the conditions requiſite for a perpendicular poſture; as may be obſerved in the Quadrumana and Sarcophaga: 2d, on the length and obliquity of the neck of the femur, which carries that bone more outward, and removes it farther from its articulation than in any other animal.

The great ſuperficies of the human foot is a conſequence of the tarſus, metatarſus, and all the toes reſting on the ground. This does not take place ſo perfectly in any other animal as man. The end of the os calcis is elevated even in *monkies* and *bears*, while in man, on the contrary, it forms a downward projection to ſuſtain the foot poſteriorly. The genus *didelphis* alſo very much reſembles man in the hind feet, but theſe animals want all the other requiſites for ſtanding. The quadrupeds which have the tarſus longer than that of man, have it at the ſame time narrower, and touch the ground with the points of their toes only.

Man, likewiſe, ſurpaſſes all quadrupeds in the advantageous form of his foot, and its aptitude to place itſelf firmly on the ground.

It is flat inferiorly, and both its edges reſt upon the earth. In other animals the foot is commonly convex, or rather as in the *monkies*; it is articulated in ſuch a manner with the tibia, that it reſts only on its external ſide. This diſpoſition is, however, neceſſary to them, as it gives them the free uſe of their pollex or great toe, and of their long toes. Even the length of the toes, which is ſo uſeful to *monkies* in ſeizing the branches of trees, is extremely inconvenient when they are placed on level ground; for their power is diminiſhed, in proportion to their length, when they merely preſs upon a plane ſurface, and have no round part to encircle. The toes of man, on the contrary, are ſhort and thick: his pollex is very ſtrong, and longer than the other toes. This conformation, which adds to the extent of the foot, does not occur in the other mammalia. It ſhould alſo be obſerved, that the human toes have neither nails nor horn inferiorly, which would obſtruct their application to the ground, and prevent them from diſcerning its inequalities.

Laſtly, the *flexor brevis digitorum pedis* in man is ſituated entirely under the foot, and ariſes before the heel: it has nothing in common with the muſcle improperly called *plantaris gracilis*, which is inſerted into the os calcis, along with the other extenſors of the foot: the flexor longus paſſes by the ſide of the os calcis; ſo that neither of theſe muſcles are confined by the heel when it reſts upon the ground.

On the contrary, the *plantaris gracilis* ſerves even partly in the monkey, and more completely in the other mammiferous animals, to bend the toes: It paſſes over the head of the os calcis, and its action would be obſtructed were it compreſſed between that bone and the earth.

The weight of the body tends to bend the leg forward on the foot: it is therefore maintained in its proper poſition by the extenſors of the heel. Theſe muſcles are the gemelli and the ſoleus. They are proportionally thicker in man than in the other mammalia, except perhaps in thoſe that are remarkable for great leaps. This is the reaſon why man is the only animal that has real calfs to the legs, and why the men that exerciſe thoſe muſcles moſt, as the perſons who practiſe leaping, have them always thicker than others.

The thigh of man, when ſtanding, forms one line with the trunk and the leg: In quadrupeds, on the contrary, it is ſituated cloſe upon the flank, and frequently forms an acute angle with the ſpine. In conſequence of this difference, the thigh is flat in thoſe animals, and round in man.

The extenſors of the thigh are proportionally ſtronger in man than in other animals: It is the contrary, however, with the flexors, which, beſides, deſcend much lower on the leg in quadrupeds, and thereby prevent the complete extenſion of the leg upon the thigh.

In the extenſion of the leg, the rotula aſcends in a groove, ſituated below, and before the femur;

this reaches higher up in man than in the other mammalia.

The thigh moves upon the pelvis in every direction, but the weight of the body tends chiefly to bend it forward. On this account its extenſors, and particularly the gluteus maximus, are ſo conſiderable in man, that he is the only animal poſſeſſed of what are properly called hips, as he is the only one that has true calfs.

In conſequence of this ſtructure, our inferior extremities are furniſhed with a ſufficient baſe, and ſolid columns for ſupporting the trunk. It was alſo neceſſary that the trunk itſelf ſhould be maintained in equilibrium in all its parts.

The firſt advantage which man poſſeſſes in this reſpect, conſiſts in the breadth of his pelvis. Its form is ſuch, that his trunk reſts on an extenſive baſe; and the muſcles of the abdomen, as well as all thoſe that proceed from the pelvis, have a ſufficient hold, at their inferior attachments, to enable them to counteract, inſtantly, the moſt minute deviations of the trunk from its erect poſition. In all the multidigital animals, the pelvis is ſo narrow that the trunk reſembles an inverted pyramid. It will be eaſily conceived, that, with ſuch a form, it would be much more difficult to preſerve the equilibrium of the body, were theſe animals to attempt to ſtand upon their poſterior feet. In the animals that ſomewhat reſemble man with reſpect to the breadth of the pelvis, viz. thoſe with hoofs, there are a number of other circumſtances which prevent that part of their ſtructure from becoming uſeful to them. *Bears* and *ſloths* are the only animals in which the width of the pelvis, which, however, is much leſs conſiderable than in man, is not completely counteracted by the form of the feet. Theſe ſpecies, therefore, ſtand more frequently on their hind feet than any others.

The ſecond advantage poſſeſſed by man is the facility with which he holds his head erect. In treating of its articulation, we have ſhewn that this is owing to the poſition of the foramen magnum, under the middle of the head, and the horizontal direction of the eyes and mouth. Theſe two peculiarities are as unfavourable to his progreſſive motion on the four members, as they are uſeful to him while he preſerves himſelf on two only. Man, walking on all-fours, could not ſee before him: It would even be painful to him to raiſe his head, which is very heavy, as its muſcles are weak, and it wants the cervical ligament.

We obſerve, beſides, ſome circumſtances in the ſtructure of man, which, though they do not aſſiſt him to ſtand upon his legs, prevent him from uſing the four extremities. His poſterior members are very long in proportion to the anterior: in conſequence of this, weak children, that cannot walk on their legs, are obliged to crawl on their knees, or to ſeparate the legs, in a manner that renders their poſition very conſtrained; but even then their head is ſo filled with blood, that they are obliged to ſeek ſomething to cling to in raiſing themſelves up.

The quadrupeds that ſometimes try to ſtand on their hind feet only, in order that they may either employ their fore-feet in taking hold of ſome object, or avoid keeping their head too low, ſeem rather to ſit than to ſtand. Their trunk reſts at the ſame time on the hind feet, as far as the heel, and on the buttocks: it is ſtill neceſſary, however, that their head and neck ſhould be proportionally ſmall, as in *monkies*, *ſquirrels*, *oppoſſums*, *&c.* otherwiſe the weight of thoſe parts would be too great for the force employed in their elevation; but even when ſeated, the animal is generally obliged to reſt on the fore-feet, as may be obſerved in *dogs*, *cats*, *&c.*

Some quadrupeds uſe their tail as a third foot, to enlarge the baſe of the body; and when it is ſtrong, it is capable of contributing to their ſupport for ſome time. We find examples of this in the *kanguroos* and *jerboas*.

B. *Standing on Two Feet, with the Body not vertical.*

As the anterior extremities of birds conſtitute their wings, they cannot be employed by thoſe animals, either in ſupporting themſelves on the ground, or in ſeizing objects. This rendered it neceſſary, that, though ſtanding on their poſterior extremities, they ſhould be able to reach the earth with their bill. It was alſo a neceſſary conſequence, of the faculty of flying, that the body ſhould have its centre of gravity nearly under the ſhoulders, in order that it might be ſuſtained by the wings. It follows, therefore, that the bodies of birds muſt be heavieſt anteriorly. Theſe two requiſites are the cauſes of all the peculiarities we obſerve in the ſkeleton of the animals of this claſs.

It muſt alſo be obſerved, that, to ſuſtain the ſame centre by the feet, when ſtanding, it was neceſſary that theſe members ſhould be directed forward: hence the great flexion of the femur, and that of the tarſus on the leg. The length of the anterior toes alſo contributes to extend farther, in the ſame direction, the ſurface on which the line of gravitation falls; and in general, the length of theſe toes is ſuch, that birds can eaſily ſtand upon one leg, without allowing the vacillatory motions of the body to remove that line beyond ſo broad a baſe.

The birds which have their feet ſituated far back on the body, as the *grebes*, and the *penguins*, are obliged to ſupport themſelves in nearly a vertical poſition.

The length and flexibility of the neck is alſo of very great uſe, in varying the poſition of the centre of gravity, ſo as to preſerve the equilibrium of the body. In ſtanding, birds generally carry the head erect: in ſleeping, they turn it towards the back, and place it under the wing, in order to lay the greateſt weight on the point above the feet.

At the commencement of this Lecture we deſcribed the mechanical means by which the long-legged birds keep the tibia extended on the tarſus, without any voluntary contraction of their muſcles. Borrelli long ago explained the mechaniſm by which perching birds claſp the branches of trees, and maintain their hold without a conſtant attention, and even ſleep in that poſition. It conſiſts in the tendons of the flexors of the toes paſſing over the articulation of the heel, and their union with a muſcle which comes from the region of the pubis, and paſſes over the knee. By the flexion of theſe two articulations the tendons are neceſſarily drawn upward, which cauſes the toes to bend. In conſequence of this conformation, the knee and the heel, even of a dead bird, cannot be bent without producing at the ſame time an inflexion of the toes. The mere weight of the body of birds, preſſing down the femora, and tibiæ, is therefore ſufficient to make their toes graſp any twig on which they chooſe to perch. I am not of opinion that the objections which have been made to this ingenious explanation are well founded, or that the theories which have been offered in its ſtead are admiſſible.

C. *Standing on Four Feet.*

We have already pointed out the cauſes which prevent quadrupeds from ſtanding erect. Theſe cauſes become the more powerful in proportion as the animals are more completely quadrupeds; that is to ſay, as they are leſs capable of diſpenſing with the uſe of their four feet in ſtanding, and as theſe members are provided with a peculiar ſtructure calculated to favour that poſition.

An animal which ſtands on four feet is ſupported on a very conſiderable baſe; but, in conſequence of the weight of the head and neck, the centre of gravity is ſituated nearer to the fore than the hind legs. It follows, therefore, that the anterior extremities, which give no ſupport to the human body, ſuſtain almoſt the whole burthen in quadrupeds. They are therefore furniſhed with very ſtrong muſcles, particularly thoſe of the fore-arm, as we have ſhewn in deſcribing them. The ſituation of the ſcapulæ being very low, the body is ſuſtained between them by the ſerratus magnus, which is much larger than it is found in man. In ſhort, all that the poſterior extremity ſeems to want in muſcular force, appears to be transferred to the anterior.

As the head inclines towards the horizon, and is projected forward by a neck which is often very long, it requires very powerful means to ſuſtain it: they are found in the great ſize and extenſive attachments of the muſcles of the neck, and the ſtrength of the cervical ligament. Theſe are two peculiarities that do not exiſt in man, whoſe head is ſupported by its vertical poſition. The ſtrength both of the muſcles and ligament is in proportion to the weight of the head and the magnitude of the horns. But when they have to raiſe burthens of an extraneous nature, as is the caſe with the *mole*, the muſcles are ſurpriſingly ſtrengthened, and the cervical ligament is oſſified.

The body hangs between the four legs, and tends by its weight to bend the ſpine downward. This effect, however, is counteracted by the abdominal muſcles, and particularly by the muſculi recti, which produce a curvature in the oppoſite direction. The extenſors of the ſpine do not aſſiſt in the operation; on the contrary, their action aids that of the weight of the trunk. The abdominal muſcles act with peculiar force in bending the vertebral column upward, and giving it an arched-like form in all the mammalia that are covered with ſcales or ſpines, and which are accuſtomed to roll themſelves up on the approach of danger, as the *hedgehog*, the *armadillos*, and the *pangolins*. Theſe muſcles are therefore ſtronger in them than in the other families. The *long-tailed pangolin*, or *phatagin*, has two tendinous, and even almoſt oſſified, productions, which extend from the xiphoid cartilage nearly to the pelvis.

The legs of mammiferous quadrupeds move forward and backward in planes nearly parallel to the ſpine, and not far diſtant from the middle plane of the body upon which the weight operates. In oviparous quadrupeds, on the contrary, the thighs are directed outward, and the inflexions of the limbs take place in planes perpendicular to the ſpine. In the latter caſe, then, the weight of the body acts with a much longer lever in oppoſing the extenſion of the knee. Theſe animals, therefore, have the knees always bent, and the belly dragging on the ground between their legs. On this account they have received the name of *reptiles*.

ARTICLE II.

Of Walking.

ALL the progreſſive motions by which man and the inferior animals remove their bodies from one place to another, require that a determinate velocity ſhould be communicated, in a particular direction, to their centres of gravity. To effect this, it is neceſſary to extend a certain number of articulations, which have been more or leſs bent, and having ſuch a poſition that their extenſion may be eaſy on the ſide to which the centre of gravity inclines, and difficult on the oppoſite ſide, in order that the principal part of the movement may take place in the former direction.

The body of an animal which attempts to make a complete change of poſition, may be compared to a ſpring divided into two branches, one of which reſts upon a reſiſting body. If theſe branches, after being brought together by external force, are again ſet free, their elaſticity will tend to make them recede equally, until they form the ſame angle with each other which they formed before their compreſſion. But the branch which bears againſt the fixed body not being able to overcome its reſiſtance, the movement will wholly take place in the oppoſite direction, and the ſpring's centre of gravity will be forced from the reſiſting body with more or leſs velocity.

This is the moſt ſimple and correct idea which can be formed of the progreſſive motion of animals. The flexor muſcles of the part which they employ in each kind of movement, repreſent the external force that compreſſes the ſpring. The extenſors correſpond to the elaſticity which tends to make the branches fly aſunder, and the reſiſtance of the ground, or that of the fluid in which they move, repreſents the obſtructing body.

Walking is a motion on a fixed ſurface, in which the centre of gravity is alternately moved by one part of the extremities, and ſuſtained by the other, the body never being at any time completely ſuſpended over the ground. By this definition it is diſtinguiſhed from *leaping*, in which the whole of the body is projected into the air; and from *running*, which is only a ſucceſſion of ſhort leaps.

A. *Walking on Two Feet.*

Animals which ſtand erect on two legs, ſuch as man and birds, walk alſo on two legs. But ſeveral quadrupeds that cannot ſtand on two feet but with great difficulty, may yet move in that poſture for ſome time with ſufficient eaſe. This ariſes from its being in general leſs painful to walk than to ſtand, the ſame muſcles not being continued ſo long in action; and alſo, it is leſs difficult to connect the unſteady motions of the body by contrary and alternate vacillations, (a thing eaſy in walking,) than it is to prevent them altogether.

When man intends to walk on even ground, he firſt advances one foot: his body then reſts equally upon both legs, the advanced leg making an obtuſe angle with the tarſus, and the other an acute angle. The ground not yielding to the point of the foot, the heel and the reſt of the leg muſt of neceſſity be raiſed, otherwiſe the heel could not be extended. The pelvis and trunk are conſequently thrown upward, forward, and ſomewhat in a lateral direction. In this manner they move round the fixed foot as a centre, with a radius conſiſting of the leg belonging to that foot, which, during this operation, continually diminiſhes the angle formed with the tarſus. The leg which communicated this impulſe is then thrown forward, and reſts its foot upon the ground; while the other, which now forms an acute angle with its foot, has the heel extended in its turn, and in like manner makes the pelvis and trunk turn round upon the former leg.

It will be ſeen that by theſe movements the centre of gravity of the body is carried forward at each progreſſive ſtep, inclining, however, at the ſame time, to the right and left alternately, ſo as to be ſupported by each leg in its turn. It will alſo be ſeen that each leg, immediately on extending its heel, bends and riſes, in order to its being moved forward; extends in order to reſt its foot upon the ground; turns upon this foot as on a fixed centre, ſo as to ſupport the weight of the body; and then extends its heel anew, in order to transfer this weight to the other leg.

Each leg ſupporting the body in its turn, in the ſame manner as in the poſition of ſtanding on one foot, the extenſors of the thigh and the knee are then brought into action, to prevent theſe articulations from giving way. The flexors, too, of the ſame articulations, act immediately after, when that leg, having thrown the weight of the body on the other, muſt be raiſed previouſly to its being carried forward. The three principal articulations of each leg are ſituated in contrary directions, in order that, during their flexion, the foot ſhould be raiſed immediately over the place it occupied during their extenſion. Were not this the caſe, it would be impoſſible to bend them without throwing the foot forward or backward.

It is the impoſſibility of regulating this undulatory motion in a manner perfectly equal on both ſides, that prevents man from walking in a ſtraight line, or even from keeping an uniform direction, if he be not very careful to correct his deviations. This is the reaſon why a man cannot walk in a ſtraight line with his eyes ſhut.

In walking down an inclined plane, or deſcending a ſtair-caſe, the advanced leg is placed lower than that which remains behind, and the body would fall on it with a fatiguing and dangerous rapidity, were it not carefully checked by means of the extenſors of the hip, which permit it to deſcend only by degrees. This is the reaſon of the loins being fatigued in deſcending.

In walking upwards on an inclined plane, or in aſcending a ſtair-caſe, it is requiſite, at each ſtep, not only to tranſport the body horizontally, as in walking on level ground, but to bear it up againſt its own weight, by means of the extenſors of the knee of the advanced leg, and thoſe of the heel of that which is behind: this is the reaſon of the knee and calf of the leg being fatigued in aſcending. We have then an advantage in inclining the body forward, becauſe the lever by which its weight acts on the knee is ſhortened in an equal proportion.

In walking with a very wide ſtep, one feels a fatigue ſimilar to that produced by the action of aſcending; becauſe the legs being conſiderably apart, the body ſinks lower at the moment of their ſeparation, and it is neceſſary that it ſhould be proportionally raiſed when turning alternately on each leg.

Man ſeldom ſwings his arms in order to aſſiſt his walking, except in a very narrow path from which he cannot depart; and then he employs all poſſible means to correct the vacillatory motion of the body. But apes always require the aſſiſtance of theſe extremities in walking, and thoſe which have the longeſt arms uſe them with the greateſt advantage, as the *long-armed monkey*, and the *orang outang*.

B. *Walking on Four Feet.*

In the action of walking, a quadruped firſt ſlightly bends the articulations of the hind legs, and then extends them in order to carry forward the body. The breaſt being thrown forward by this movement, to which the extenſors of the knee and the heel particularly contribute, the fore-legs become inclined backward; and the animal would certainly fall, did it not inſtantly throw them forward in order to ſupport itſelf. It then draws up the trunk upon the fore-legs fixed in this poſition, and the hind-legs are again brought into action.

But it muſt be obſerved, that theſe movements are not performed at the ſame moment, by the two legs of each pair in the action of walking; for, in that caſe, the animal would neceſſarily be completely ſuſpended for a moment over the ground; and its motion would then be no longer a *walk*, but a ſucceſſion of leaps, particularly denominated a *full-gallop*, of which we ſhall treat in the ſequel.

Each ſtep is executed by two legs only; one belonging to the fore-pair, and the other to the hind-pair; but ſometimes they are thoſe of the ſame ſide, and ſometimes thoſe of the oppoſite ſides.

The latter is that kind of motion in horſes which grooms term a *pace*. The right fore-leg is advanced ſo as to ſuſtain the body, which is thrown upon it by the extenſion of the left hind-foot; and at the ſame time the latter bends in order to its being moved forward. While they are off the ground, the right hind-foot begins to extend itſelf, and the moment they touch it the left fore-foot moves forward to ſupport the impulſe of the right foot, which likewiſe moves forward. The body is thus ſupported alternately by two legs placed in a diagonal manner.

When the right fore-foot moves in order to ſuſtain the body, puſhed forward by the right hind-foot, the motion is then called an *amble*. The body being alternately ſupported by two legs of the ſame ſide, is obliged to balance itſelf to the right and left, in order to avoid falling; and it is this balancing movement which renders the gait ſo ſoft and agreeable to women and perſons in a weak ſtate of body.

In the animals that have the fore-feet longer than the hind, and have their ſtrength chiefly in the anterior part of the body, the principal impulſe is given by extending the fore-foot. The hind-foot then riſes to follow it, and it is not until the moment that the latter extends itſelf in its turn, that the fore-foot is raiſed. This is the manner in which the *giraffe* is ſaid to move.

But when the fore-legs are greatly diſproportionate to the others, and particularly when the poſterior extremities are feeble and badly articulated, as in the *ſloths*, the animal is obliged to drag itſelf onward, by firſt extending the anterior legs, and then bending them ſo as to draw the body after them; the hind-legs affording but very little aſſiſtance by their impulſion. It is this circumſtance which renders the progreſſion of the *ſloths* ſo laborious.

Thoſe animals which have their fore-legs very ſhort in proportion to their hind ones, would be incapable of ſufficiently ſupporting their bodies, and muſt fall down forward on each impulſe of the latter, had they not the precaution to make a prancing movement; that is, to raiſe the anterior extremities entirely off the ground, previouſly to their being impelled onward by means of the hind-feet. Accordingly ſuch animals cannot in propriety of language be ſaid to walk; they only move forward by leaps. This is the caſe with the greater part of the Rodentia, ſuch as the *hares*, the *rats*, and particularly the *jerboas*. Indeed theſe animals cannot be ſaid to walk at all, except in the action of aſcending. When they attempt to walk ſlowly on level ground, they are obliged to move themſelves by the fore-feet, and merely to drag after them the hind-pair. This may be obſerved in *rabbits*, and ſtill more diſtinctly in *frogs*.

When the hind-feet are very much ſeparated, their impulſe becomes more lateral. It thence reſults that, at each ſtep, the trunk is alternately impelled ſide-ways, and that the line of motion becomes crooked. This may be remarked in the ſwimming animals, whoſe manner of life requires that there ſhould be a conſiderable ſpace between the hind-legs; ſuch as the *otters*, the *beavers*, the *tortoiſes*, *&c.*

ARTICLE III.

Of the Actions of Seizing and Climbing.

MAN, and a certain number of other animals, are capable of ſeizing objects, by ſurrounding and graſping them with their fingers. For this purpoſe it is neceſſary that their fingers ſhould be ſeparate, free, flexible, and of a certain length. Man has ſuch fingers on his hand only; but *apes* and ſome other kinds of animals have them both on their hands and feet.

Only *man*, *apes*, and *lemurs*, have the thumb ſeparate, and capable of being oppoſed to the other fingers, ſo as to form a kind of forceps. Theſe are therefore the only animals that can hold moveable objects in a ſingle hand. We ſhall ſhew hereafter the great difference between the hand of the ape and that of man, and the advantage which the latter poſſeſſes for all delicate operations, in which it is neceſſary to handle, or pinch minute bodies. The other animals, that have the fingers ſufficiently ſmall and flexible to enable them to take up objects, are obliged to hold them in both hands. This is the caſe with *ſquirrels*, *rats*, *oppoſſums*, *&c.* Others which have the toes ſhorter, and which beſides are under the neceſſity of reſting on their fore-feet, as *dogs* and *cats*, can only hold ſubſtances by fixing them upon the ground with their paws. Laſtly, thoſe that have the toes united and drawn together under the ſkin, or enveloped in corneous hoofs, are incapable of exerciſing any prehenſile power.

We have already ſhewn that perfect prehenſion always requires the power of rotating the hand upon the fore-arm, and that in all the animals which poſſeſs theſe faculties, the bones of the ſhoulders ſhould be ſo ſituated as to prevent the diſplacing of the ſcapula forward.

The faculty of ſeizing or graſping firmly is particularly uſeful to animals in that ſpecies of progreſſion called *climbing*. This motion conſiſts in hanging from, and ſtrongly graſping the inequalities of branches, or any other object ſuſceptible of being ſeized or graſped, and riſing in this manner by ſucceſſive efforts, in a direction oppoſite to the animal's weight.

Man is a very indifferent climber, becauſe he can only graſp with his hands. His feet are merely fitted for ſupporting him, and this circumſtance gives them much leſs ſecurity in elevating the body by the extenſion of the heels and knees. He is obliged to employ his arms chiefly by extending them forward, and drawing up his body after them when he has fixed his hands.

Of all climbers the quadrumanous animals are the beſt. They can ſeize equally well with their four extremities; and the poſition of their hind-feet, the ſoles of which turn inward, inſtead of being directed downward, is ſtill farther favourable to them.

The other animals that climb conſtantly, as the *oppoſſums*, the *phalangers*, the *ant-eaters*, and the *ſloths*, have a ſimilar conformation. The two firſt have the thumb almoſt always directed backward, and forming a kind of heel, very powerful in its operations. The *ſloths* and the *ant-eaters* have a conſiderable protuberance on the heel, which accompliſhes in a certain degree the ſame effect.

Several Quadrumana, the *oppoſſums*, *phalangers*, and *ant-eaters*, may be ſaid to have a fifth member which aſſiſts them in climbing. They can ſeize bodies with their tail almoſt as powerfully as with the hand. The muſcles which produce this motion do not differ from thoſe of other tails, except in poſſeſſing a greater degree of force.

The animals of the *cat* genus climb by fixing their ſharp cutting and hooked claws into ſubſtances. We have already explained the manner in which their nails are retained between the toes, with the point elevated, independently of the will of the animal, by two elaſtic ligaments. When they wiſh to uſe them, they are protruded by the action of the flexor profundus digitorum, which moves the laſt phalanx on the preceding one, and directs the point of the nail downward. This is the mechaniſm which enables *cats* to ſeize moveable objects, and to tear their prey.

The diſpoſition of the ligaments is very different in the *ſloths*. Their nails are naturally inflected under the toes, and when the animal wiſhes to uſe them, it is obliged to raiſe them by the extenſor muſcles. Theſe toes, beſides, are not very convenient, as they are compoſed of only two phalanges; one of which is very ſhort, and the other entirely covered with the nail. The metacarpal bones, too, are oſſified together, and immoveable.

The climbing birds likewiſe fix themſelves to the inequalities of the bark of trees by their claws. It is the poſterior toes which are chiefly uſed in ſupporting them, and preventing them from falling. Some genera, as the *creepers* and the *nut-hatches*, have only one poſterior toe; the greater part have two. The *wood-peckers*, and the *creepers*, have another ſupport in their tail, the quills of which are very ſtiff, and capable of being ſtrongly fixed upon the ſurfaces over which theſe birds climb.

Birds can only exerciſe the faculty of prehenſion with their feet; but as theſe are neceſſary to ſuſtain them, few genera employ their toes in this manner, except when flying, becauſe then their feet are free, or ſometimes in ſwimming with a ſingle foot, as the *pelicans* and the *cormorants*.

Some birds can lift food to the mouth with one foot, while they ſtand upon the other. The *parrots* and the *owls* are moſt remarkable for the exerciſe of this faculty; the former on account of the convenient diſpoſition of the toes, and the latter in conſequence of the weight of the head, which would occaſion them to fall frequently were they always to extend it downward in order to peck.

Wading birds, being capable of preſerving the articulations of their legs in an extended ſtate, without much effort, are alſo frequently accuſtomed to ſtand on one foot: to balance themſelves more perfectly in this poſition, they hold a ſtone or ſome other heavy ſubſtance in the other.

The forceps, like hands, and prehenſile tail of the camelion, ſeem to give to that animal, though belonging to the claſs Amphibia, a form not leſs advantageous for climbing than that of the Quadrumana among mammalia.

ARTICLE IV.

Of Leaping.

LEAPING is a motion in which the body riſes completely from the earth, darts as it were into the air, and remains without any ſupport for a momentary period, the duration of which depends upon the force of the projection.

Leaping is performed by a ſudden extenſion of all the inferior articulations, immediately after they have undergone an unuſual degree of flexion. This extenſion gives to the bones that compoſe theſe articulations, a violent motion, the impulſe of which being communicated to the centre of gravity of the body, it is projected with a determined velocity, which is more or leſs in oppoſition to its weight.

A leaping body may then be conſidered as a projectile which gradually loſes the acquired velocity by which it aſcended, becauſe the power of gravity is every moment counteracting that velocity. The projectile force therefore being given, we may aſcertain the arch a leaping body will deſcribe in the air, and the time and place of its deſcent.

The projectile force, and conſequently the extent of the leap, depends on the proportional length of the bones and the ſtrength of the muſcles. The animals therefore that leap beſt, are thoſe which have the poſterior legs and thighs longer and thicker than the anterior, as the *kanguroos*, *jerboas*, *frogs*, *alticæ*, *grylli*, *fleas*, &c.

The ſmall animals leap proportionally much farther than the larger. This muſt be obvious, if we conſider, that when the projectile force impreſſed on two bodies is in proportion to their different magnitudes, their velocity will be equal, and that the extent of the ſpace through which they will paſs depends entirely upon their reſpective velocities. The leaps of ſmall and large animals are therefore nearly equal.

The direction of a leap depends on the ſituation of the centre of gravity, with reſpect to the member by which the impulſe is given. This is the reaſon why man and birds are the only animals which can leap vertically, becauſe they only have the trunk ſituated above the members, by which the leap is effected. They may, however, leap forward, by impreſſing a greater degree of force on the rotatory motion of the thigh than on that of the leg; or they may even leap backward, by making a contrary exertion.

Quadrupeds and moſt inſects can only leap forward. *Spiders*, however, which have ſeveral long feet on each ſide of their bodies, can leap ſideways, as well as forward.

Running is a ſeries of low leaps performed alternately by each leg. It only differs from walking in the body being projected forward at each ſtep, and in the poſterior foot being raiſed before the anterior touches the ground. It is more rapid than the quickeſt walking ſtep, becauſe the acquired velocity is preſerved and augmented at each bound by the new velocity which is added to it. An animal therefore cannot ſtop inſtantaneouſly when running, though a ſtop may be made in walking at each ſtep. The velocity acquired by running is advantageous in leaping forward, as it adds to the velocity of the leap itſelf in the ſame direction, but it would prove unfavourable to a vertical leap, and even entirely prevent it. An animal in running inclines its body forward, in order that the centre of gravity may be in the proper poſition for receiving an impulſe in that direction from the poſterior leg. It is alſo obliged to move the anterior leg rapidly forward, to guard againſt falling. The leaſt obſtacle which would ſtop this leg, and prevent it from reaching the ground ſoon enough to ſupport the body, would occaſion a fall.

Interruptions of this kind are, on account of the greater velocity, much more dangerous in running than in walking. On that account, too, falls occur moſt frequently in the former motion.

Man never varies his manner of running, except in taking longer or ſhorter ſteps, or in giving to his motion a greater or leſs degree of rapidity; but quadrupeds vary their mode of running by the different order in which they raiſe each foot, or bring it to the ground.

Trotting is a mode of running in which the feet diagonally oppoſite riſe at once, and fall at once, each pair alternately, but in ſuch a manner that, for a moment, all the four feet are off the ground. This produces a regular motion, and the ſound of the animals ſteps are heard two and two in ſucceſſion.

Galloping is a running motion in which the animal raiſes the anterior feet at each ſtep, and throws the body forward by the extenſion of the poſterior feet. When the two fore-feet deſcend at the ſame time, and are followed by the two hind-feet alſo deſcending together, the motion is called a *full gallop*, which is the moſt rapid a *horſe* can perform, and the only mode of running in *dogs*, *hares*, &c. In this kind of gallop the ſteps of the horſe are likewiſe heard by two beats at a time. The *common gallop* is when the two fore-feet are lifted unequally and fall one after another. This may be divided into *gallops* in which the horſes footſteps are heard by a ſeries of *three* or of *four* beats, becauſe the poſterior feet may fall to the ground either both together, or one after the other. All theſe circumſtances have been ſufficiently explained by riding-maſters and hippotomiſts.

There are ſeveral kinds of animals which leap by the means of organs different from feet, but always by a ſudden extenſion of ſeveral articulations.

Serpents leap by folding their bodies into ſeveral undulations, which they unbend all at once, according as they wiſh to give more or leſs velocity to their motion; ſome may be aſſiſted by the ſcales of their belly, which they can elevate and depreſs, but only a few genera are capable of employing this means.

Some fiſhes alſo leap to the tops of cataracts by bending their bodies ſtrongly, and afterwards unbending them with an elaſtic ſpring.

The long-tailed *cray-fiſhes*, particularly the *ſhrimps*, leap by extending the tail after it has been previouſly bent under the body.

The larva of the *fly*, vulgarly called the maggot, forms itſelf into a circle, contracts itſelf as much as poſſible, then ſuddenly unbending, darts forward to a conſiderable diſtance.

The *poduræ* have a tail formed of two articulations, which being inflected under their abdomen, and afterwards extended, enables them to make very conſiderable leaps.

Article V.

Of Swimming.

Leaping commonly takes place on a fixed ſurface, which poſſeſſes the power of reſiſtance, in conſequence of its magnitude and its firmneſs. Though this ſurface yield to a certain degree, in conſequence of being either ſoft or elaſtic, leaping can ſtill be performed; but the retrograde motion of the ſurface produces a diminution in the velocity of the leap, compared with that which is made from firm ground; and the velocity is always greater in proportion as the reſiſtance is perfect. To continue the example which we before adopted, of a ſpring of two branches tending to ſeparate from each other, it is evident that if one extremity did not experience a greater reſiſtance than the other, the middle of the ſpring would not change its place: but in proportion as there is a difference in the reſiſtance, a motion muſt be produced in the direction oppoſite to the reſiſting body.

Swimming and flying are leaps which take place in fluids, and are produced by the reſiſtance theſe fluids make to the impulſe of certain ſurfaces, which ſwimming or flying animals move with great rapidity.

This velocity is neceſſarily great in proportion to the rarity of the medium. The muſcles which produce it require, therefore, a force vaſtly ſuperior to that which is neceſſary for a ſimple leap upon a ſolid ſurface; but there is ſtill another requiſite for motions which take place in fluids: The body being entirely ſurrounded by theſe mediums, would find an equal reſiſtance on all ſides, and the velocity acquired by ſtriking the fluid poſteriorly, would ſoon be overcome by the quantity that muſt be diſplaced anteriorly, if the animal had not the power of conſiderably diminiſhing its ſurface immediately after it has ſtruck the fluid.

Swimming and flying belong to different claſſes of animals. There are ſome, however, which unite both theſe ſpecies of motions; but the one is performed in the moſt perfect manner by fiſhes, and the other by birds. We ſhall, in the firſt place, conſider the means which theſe two claſſes employ, and compare them afterwards with thoſe employed by the ſpecies of other claſſes.

As all birds do not fly, ſo all fiſhes do not ſwim. Thoſe which ſwim beſt have the body ſomewhat elongated, and moderately compreſſed.

An animal may either ſwim in an horizontal plane, or in a direction more or leſs inclined. We ſhall, in the firſt place, conſider this motion as it takes place in a horizontal plane. A fiſh, when in equilibrium with the water, (a ſtate in which it can place itſelf by means which we ſhall hereafter explain,) and wiſhing to advance, bends its tail in two different directions, ſimilar to the figure of the letter S, by the means of thoſe ſtrong and complicated lateral muſcles which we have already deſcribed. The animal then extends the dorſal, the anal, and the caudal fins, as much as poſſible, in order to augment the ſurface of the tail. This member is next extended with great velocity, and according to the principle we have eſtabliſhed above, the reſiſtance of the fluid, that is to ſay, the difference of the velocity it admits, with that which the effort of the fiſh tends to impreſs upon it, anſwers, as it were, inſtead of a ſolid ſurface. The body of the fiſh is therefore impelled forward by the remainder of that velocity.

The water before the fiſh gives leſs reſiſtance to its progreſſive motion; 1ſt, becauſe the velocity by which it advances is much leſs than that which it employs to extend the tail; 2d, becauſe when the tail returns to a right line, the fiſh preſents to the fluid only the thickneſs of its body, which is far from being conſiderable.

It is neceſſary that the fiſh ſhould bend its tail again to give a ſecond ſtroke to the water. This motion, however, is directly contrary to that by which the tail is extended, and produces, in the fluid, a reſiſtance in the oppoſite direction, which would be equally powerful, and would completely counteract the animal's progreſſive motion, if the ſurfaces of the body remained the ſame; but the dorſal and anal fins are then laid down upon the body; the caudal fin becomes folded and narrow; beſides, the curvature of the tail takes place very ſlowly, while its extenſion is ſudden and violent. After having returned to the right line, the tail is incurvated a ſecond time; it then bends preciſely in the oppoſite direction, and the impulſe which reſults from it having an equal obliquity, but oppoſite to that which reſulted from the firſt ſtroke, the courſe of the body is rendered ſtraight.

It is by ſtriking the water with more force on one ſide than on the other, that the fiſh is enabled to move to the right or the left, and to turn horizontally.

With reſpect to the power of riſing or ſinking in the water, it appears in the greater number of fiſhes to depend on the air-bag or ſwimming-bladder. We ſhall deſcribe the form, the connection, and the ſtructure of this important organ, when we treat of ſecretions. At preſent we can only conſider its uſe in progreſſive motion. It is ſufficient to obſerve, that it is a bladder of greater or leſs magnitude, ſituated within the abdomen, cloſe to the ſpine, ſometimes ſimple, ſometimes double; but, in the latter caſe, the two parts communicate by a ſmall canal. There is frequently a duct which leads from this bladder into the œſophagus or the ſtomach; but it appears that the air contained in the bag cannot paſs through this duct without the conſent of the animal. This air is produced, as I think I ſhall be able to prove in the Lecture already referred to, by the means of certain organs, which ſeparate it from the blood, and in a healthy fiſh it keeps the bag always diſtended.

When the air-bag is burſt, the fiſh is no longer able to riſe in the water, but remains always on its back. It follows, therefore, that this bag communicates to the back the degree of levity proper to preſerve it uppermoſt, and that in the ſtate of its greateſt extenſion, it renders the whole body ſufficiently light to enable it to aſcend in the water. There are even ſome fiſhes which are capable of being ſo dilated by the heat, that when they remain for ſome time on the ſurface of the water, acted upon by an ardent ſun, they cannot ſufficiently compreſs this bag to enable them to deſcend again. But in an ordinary ſtate the fiſh can compreſs the bag preciſely to that degree which is neceſſary to preſerve an equilibrium with the water when it wiſhes to remain in an horizontal plane. It compreſſes the bag ſtill more when it wiſhes to deſcend.

This compreſſion is accompliſhed by the lateral muſcles of the body, which tend to contract the bladder by elongating it. In this manner, though its ſurface remains equal, its capacity is diminiſhed, ſince it is farther removed from a ſpherical form.

Fiſhes that have no air-bags, poſſeſs leſs facility in changing their elevation in the water. The greater part remain at the bottom, unleſs the diſpoſition of their body enable them to ſtrike the water from above downwards, with great force. This the *rays* do with their large pectoral fins, which are very properly called wings, ſince the means theſe fiſhes employ in elevating themſelves, are preciſely the ſame as thoſe employed by birds in flying.

The *pleuronectes* ſtrike the water from above downwards, with the ſides of their bodies, becauſe they do not ſwim like other fiſh, with the back upward, and the belly downward, but in a very oblique poſition, which they are compelled to take in conſequence of their eyes being both ſituated on the ſame ſide of the head.

As the *rays* and the *pleuronectes* cannot conveniently ſtrike the water on the right and left, they are obliged to make a ſucceſſion of leaps, in order that the whole of their motions may have a horizontal direction. They ſtrike the tail downward with great force, which elevates them a little, and this motion combining with the power of gravity, brings them back after deſcribing a curve to the horizontal line. They depart from this line by a new leap, as we ſhall explain hereafter when we treat of the flight of birds.

The Cetacea employ the ſame means. Their bodies, it may be obſerved, are as perfectly organiſed for ſwimming as thoſe of fiſhes. They differ, however, in this reſpect, that in the Cetacea the principal efforts of the tail are made in a vertical direction. The uſe of the air-bag is in them ſupplied by the lungs, which are compreſſed and dilated by the action of the intercoſtal muſcles and the diaphragm.

The pectoral and ventral fins do not appear to be of much uſe in the progreſſion of fiſhes, but they employ them to preſerve themſelves in equilibrio, or a ſtate of reſt, and they extend them whenever they find it neceſſary to correct the vacillations of the body. They employ them likewiſe in the ſlight turnings of their progreſſive motion, and to prevent themſelves from falling on one ſide when ſwimming. Thoſe, however, which have them very large, doubtleſs make a more efficacious uſe of them, but our obſervations on this ſubject are not yet ſufficiently accurate.

There are ſeveral claſſes of animals which ſwim in the manner of fiſhes, that is to ſay, by inflecting the body, ſuch are ſerpents, and the larvæ of inſects, that have long bodies and no fins, as thoſe of the *water beetles*, the *hydrophilus*, the *day flies*, the *aquatic tipulæ*, and *gnats*.

But the *mammiferous quadrupeds*, the *water* *birds*, the *oviparous quadrupeds*, and the *Cruſtacea*, ſwim by the help of their feet, which are to them what oars are to a boat.

The oar in a ſtate of reſt forms two angles with the ſide of the boat; one anterior, and the other poſterior, which may either correſpond or be unequal. The boatman moves the oar ſo as to render the anterior angle more obtuſe, and the poſterior more acute. If the water did not reſiſt, the boat would not change its place; but its reſiſtance oppoſing the oar, the angle in queſtion widens by the progreſſive motion of the boat. This impulſe once given, the boatman draws back his oar or turns its edge that it may not interrupt the motion, and then recommences the ſame operation to give the boat a ſecond impulſe.

The body of aquatic birds is naturally lighter than the water, on account of their feathers, which are oily and impervious to moiſture, and on account of the great quantity of air contained in the cells of their abdomen. They are therefore preciſely in the ſituation of a boat, and have no occaſion to employ their feet, except in moving forward. The feet are ſituated farther back than thoſe of other birds, becauſe their effort is more direct; and there is no neceſſity for their giving any ſupport to the anterior part of the body, which is ſufficiently ſuſtained by the water. The thighs and legs are ſhort, that the reſiſtance of the water on the muſcles may be as little as poſſible. The tarſus is compreſſed for cutting the water, and the toes are very much expanded, or even united by a membrane, in order to form an oar of greater breadth, and capable of acting upon a greater ſurface of the water. But when the bird inflects its foot in order to give a new ſtroke to the water, it cloſes the toes upon each other to diminiſh the reſiſtance.

When theſe birds wiſh to dive, they are obliged to compreſs with much force their breaſt in order to expel the air it contains, to elongate the neck in order that the body may acquire an inclination forward, and to ſtrike with their feet upward in order that they may be forced downward.

Some acquatic birds, particularly the *ſwan*, ſpread their wings to the wind in ſwimming, and uſe them as ſails.

The quadrupeds which are the moſt perfect ſwimmers, are furniſhed with membranes between the toes, as the *otter*, the *beaver*, *&c.*; but the others may alſo ſwim with more or leſs facility, by uſing their four feet. The poſterior ſerve to puſh them forward, and the anterior to ſuſtain the fore-part of the body, which is heavieſt. Of all the mammalia man has moſt occaſion to make uſe of his hands in ſwimming, on account of the weight of his head. He is even almoſt the only animal of this claſs which cannot ſwim naturally.

The *ſeals* and the *morſes*, which have the greateſt reſemblance to the Cetacea, and fiſhes in the form of their body, are the beſt ſwimmers of all the mammalia, and they are properly called amphibious.

ARTICLE VI.

Of Flying.

WHEN a bird wiſhes to fly, it firſt darts itſelf into the air, either by leaping from the ground, or throwing itſelf from ſome height; meanwhile it elevates the humerus, and with it the whole of the wing, which hitherto remained folded. It afterwards unfolds it in a horizontal direction, by extending the fore-arm and the hand. The wing having thus acquired all the ſuperficial extent it is capable of attaining, the bird ſuddenly depreſſes it, that is to ſay, it moves it downward, until it forms, with the vertical plane of the body, an angle more obtuſe ſuperiorly, and more acute inferiorly. The reſiſtance of the air to this motion, which is ſuddenly performed in it, produces a re-action of part of the effort upon the body of the bird, which is moved in the ſame manner as in other leaps. The impulſe once given, the bird re-folds the wing by bending the articulations, and elevates it again to give a new ſtroke to the air.

The velocity which the bird thus acquires in aſcending, is, like that of every other projectile, gradually diminiſhed by the effect of gravitation; and a moment occurs in which the velocity ceaſes, and the bird neither tends to aſcend nor to deſcend. If the animal ſeizes preciſely this moment to give a new ſtroke with the wing, it will acquire a new aſcending velocity which will carry it as far as the firſt, and by repeating this it will aſcend in a uniform manner.

If the ſecond ſtroke of the wing takes place before the velocity obtained by the firſt is loſt, an additional impulſe will be received, and by continuing this action the bird will aſcend with an accelerated motion.

If the wings do not vibrate at the moment when the aſcending velocity is loſt, the bird will begin to deſcend with greater rapidity. If it allows itſelf to fall down to the point from which it departed, it cannot aſcend as high as before, except by a much ſtronger exertion of the wings; but if a point is ſeized in the fall, ſo ſituated, that the acquired deſcending velocity and the ſmall ſpace there is to re-deſcend reciprocally compenſate each other, the bird may, by a ſeries of equal vibrations, keep itſelf always at the ſame height.

When a bird wiſhes to deſcend, it has only to repeat the vibrations of its wings leſs frequently, or even to ſuppreſs them altogether. In the latter caſe it comes down with all the acceleration of gravity, as in the *darting* of birds of prey.

A bird, when deſcending, may alſo ſuddenly break its fall by extending its wings; becauſe the reſiſtance of the air augments in proportion to the ſquare of the velocity, and by adding ſome movement of the wings, it may enable itſelf to riſe again. This is called a *recover*.

We have hitherto regarded flight as ſimply vertical, without conſidering its other directions. It can be of this kind only in the birds which have the wings entirely horizontal: ſuch they probably are in *larks*, *quails*, and the other birds which we obſerve to fly ſtraight upwards; but in the greater part the wing is always more or leſs inclined and turned backward. This chiefly ariſes from the length of the quills, which afford much advantage to the reſiſtance of the air acting on their extremities, and which are the more elevated by it, on account of their fixed points being at the roots. It appears, however, that this inclination may be varied to a certain degree at the will of the bird.

Be this as it may, we may conſider the oblique motions as conſiſting of a vertical one, upon which gravity alone can act, and of a horizontal motion which it cannot affect.

When a bird therefore wiſhes to fly horizontally, it muſt riſe in an oblique direction, and make a ſecond movement of the wings when it is ready to deſcend below the point from which it departed. It will not fly in a ſtraight line, but will deſcribe a ſeries of curves ſo very much depreſſed, that the horizontal motion will overcome the vertical.

If it wiſh to aſcend obliquely, it is neceſſary that the wings ſhould vibrate quicker; if it wiſh to deſcend obliquely, they ſhould move ſlower: but theſe two motions are both performed by a ſeries of curves.

It appears that there are birds which have not the power of diminiſhing as much as they wiſh the obliquity of the wings, and in which the horizontal motion is always very conſiderable. If this motion be favoured by the wind, theſe birds are obliged to aſcend by a very inclined line; for this reaſon, the birds of prey called *noble* by the falconers, are under the neceſſity of flying againſt the wind when they wiſh to riſe perpendicularly, otherwiſe they would be carried to great diſtances.

They have a proportionally greater horizontal motion than other birds, becauſe the *anterior* quills of their wings are very long, and their extremities preſs cloſe upon each other. In the *ignoble* birds, the quills at the end of the wing have their extremities ſeparate, and allow the air to paſs between them. This renders the wing leſs capable of aſſuming an oblique poſition.

The deviations of flight, to the right or left, are principally produced by the vibrations of the wings. In turning to the right, the left wing vibrates ofteneſt, or with the greateſt force; the left ſide then moves moſt rapidly, and the body muſt of neceſſity turn. The right wing produces the ſame motion towards the left ſide. The more rapid the flight is forward, the greater is the difficulty of one wing ſurpaſſing the other in velocity, and the deviations are leſs ſudden. This is the reaſon why the birds which fly with the greateſt velocity make large circuits in turning.

The tail, when ſpread out, contributes to ſuſtain the poſterior part of the body. If it is depreſſed when the bird has acquired a progreſſive velocity, it preſents an obſtacle which elevates the poſterior part of the body, and depreſſes the anterior. If it is turned up, the contrary effect is produced. Some birds incline it to one ſide, to aſſiſt them like a rudder, when they wiſh to change their horizontal direction.

The firſt motion of a bird is an ordinary leap with the feet. Thoſe which have the feet very ſhort, and the wings very long, like the *martins*, the *booby*, *&c.* cannot leap ſufficiently high to obtain the neceſſary ſpace for the extenſion of their wings. When on the ground they therefore commence their flight with conſiderable difficulty.

It is ſcarcely neceſſary to obſerve, that the reſiſtance of the air is in proportion to the maſs which is ſtruck at one time, and that it is on this account the ſhort-winged birds are obliged to repeat their vibrations very frequently, which ſoon fatigues them, and prevents them from flying long at a time. Theſe are the motions which conſtitute flying in birds. Let us now conſider how theſe animals are enabled to execute them.

Their trunk is an oval, which is broadeſt anteriorly, and narroweſt poſteriorly. Their ſpine is almoſt inflexible, and proportionally ſhorter than that of quadrupeds. This gives leſs fatigue to the ſpinal muſcles, and renders it more eaſy to change the poſition of the centre of gravity, which muſt be between the wings in flying, and under the feet in ſtanding. The head is generally ſmall, and the bill tapering to a point, which is a convenient form for cleaving the air. Their neck is longer, and more flexible than that of the mammalia. It therefore ſupplies the want of arms, and that of flexibility in the trunk, and enables them, when neceſſary, to change the centre of gravity, by moving the head forward, or drawing it backward.

It is neceſſary that the centre of gravity ſhould conſtantly reſide in the inferior part of the body, otherwiſe the bird would fall upon its back. This is produced by the magnitude of the pectoral muſcles that depreſs the wing, and the poſition of the levators, which are ſituated under the thorax, and not above it, as in quadrupeds.

The levity of the body of birds, likewiſe, gives more facility to their elevation. It is occaſioned by their bones being hollow, which renders them light without weakening them, an empty cylinder being ſtronger than a full one of the ſame weight and length; and ſtill more by the large air cells contained in ſeveral parts of the body, and which all communicate with the lungs. The air which birds reſpire diſtends them in every part, particularly on being dilated by the warmth of their body. We ſhall deſcribe all thoſe cells when we treat of the organs of reſpiration.

Finally, the texture of the feathers, eſpecially that of the quills, and their elaſticity, greatly promote flight by the lightneſs and extent which they give to the wings. We ſhall deſcribe them in detail when we treat of the teguments of theſe animals. But it is not the feathers only which ſerve to increaſe the wing. The angles included between the humerus and the fore-arm, and between the humerus and the trunk, are furniſhed with an expanſion of the ſkin, extended by particular muſcles, which we ſhall deſcribe in treating of the panniculus carnoſus.

There are birds which never fly. Theſe are, *oſtriches*, among the terreſtrial birds; and the *penguins*, and the *manchots*, among the aquatic. Their wings are ſo ſmall that they appear only to poſſeſs them, that they may not form too marked an exception to the rules of reſemblance in the different claſſes of animals.

On the contrary, there are mammalia which fly pretty well although they have no wings; theſe are the *bats*: their humerus and fore-arm, and particularly their four fingers, are greatly elongated, and include a large ſpace occupied by a fine membrane which extends to the feet and both ſides of the tail. It forms a ſurface of ſufficient extent and firmneſs to raiſe the animal to which it belongs into the air. The bats have, beſides, very ſtrong pectoral muſcles; their body is ſhort, narrow, and ſlender behind, in ſuch a manner that the centre of gravity is ſituated under the wings; but this diſpoſition of the body, which fits them for flying, confines them alſo to crawling, becauſe their hind legs alone are not capable of ſuſtaining them.

The other mammalia, *viz.* the *flying lemurs*, the *polatouches*, or *flying ſquirrels*, and the *flying phalangers*, have membranes between the feet, but no elongation of the toes. They cannot employ theſe membranes in raiſing themſelves, but they ſerve to ſupport them for a certain time in the air, and enable them to take great leaps in deſcending, which, however, ought not to come under the denomination of flying.

The *dragon* is a ſmall lizard of the Eaſt Indies, which ſupports itſelf for ſome moments by a membrane ſuſtained like a fan on a few oſſeous radii, articulated to the ſpine of the back.

The wings of flying fiſhes are ſomewhat analogous in their ſtructure to thoſe of the dragon, but they are formed by the extenſion of the pectoral fins, or by ſome radii ſituated under theſe fins. They only enable the animal to fly for a ſhort time.

N. B. In deſcribing the muſcles and other organs of motion in white-blooded animals, we have ſufficiently explained the manner in which they are employed, and have therefore no occaſion to return to that ſubject.

END OF THE FIRST VOLUME.

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GENERAL TABLE OF THE CLASSES OF ANIMALS.

- ANIMALS
  - With Vertebræ
    - Warm blood: a heart with two ventricles
      - Viviparous: with mammæ ...... 1 MAMMALIA.
      - Oviparous: no mammæ ...... 2 AVES.
    - Cold blood: a heart with one ventricle
      - Lungs, ſometimes accompanied by branchiæ ...... 3 AMPHIBIA.
      - Branchiæ without lungs ...... 4 PISCES.
  - Without Vertebræ
    - Blood veſſels
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      - A knotted ſpinal marrow: no articulated Members ...... 6 VERMES.
      - A knotted ſpinal marrow: articulated members ...... 7 CRUSTACEA.
    - No blood veſſels
      - A knotted ſpinal marrow: articulated members ...... 8 INSECTA.
      - No ſpinal marrow: no articulated members ...... 9 ZOOPHYTA.

TABLE I.

CLASSIFICATION OF MAMMIFEROUS ANIMALS.

- MAMMALIA
  - With Claws or Nails
    - Having three ſorts of teeth
      - FAMILY I. BIMANUM. Thumbs ſeparate on the ſuperior extremities only
        - Homo ...... *Man.*
      - F. II. QUADRUMANA. The thumbs, or great toes, ſeparate on each of the four feet
        - Simia ...... *Apes*
          - Pithecus ...... *Orangs.*
          - Callitrix ...... *Sapajous.*
          - Cercopithecus ...... *Guenons.*
          - Cynocephalus ...... *Macaques.*
          - Papio ...... *Baboons.*
          - Cebus ...... *Alouates.*
        - Lemur ...... *Makis*
          - Lemur ...... *Makis or Maucaucos.*
          - Indri ......
          - Lori ......
          - Galago ......
          - Tarſius ...... *Tarſier.*
      - F. III. SARCOPHAGA. No ſeparate thumbs or great toes on the anterior extremities
        - A. CHEIROPTERA. Elongated hands: membranes extending from the neck to the anus, between the feet
          - Veſpertilio ...... *Bats*
            - Pteropus ...... *Rouſſets.*
            - Veſpertilio ...... *Common Bats.*
            - Rinolophus ......
            - Phylloſtoma ......
            - Noctilio ......
          - Galeopithecus ...... *Flying Lemurs.*
        - B. PLANTIGRADA. No ſeparate thumbs or great toes. The whole ſole of the foot applied to the ground
          - Erinaceus ...... *Hedge Hogs*
            - Erinaceus ...... *Hedge Hogs.*
            - Setiger ...... *Tenrecs.*
          - Sorex ...... *Shrews*
            - Sorex ...... *Shrewmouſe.*
            - Mygale ...... *Deſman, or Muſk Shrew.*
            - Chryſo-Chloris ......
            - Scalops ...... *Scalope.*
          - Talpa ...... *Moles.*
          - Urſus ...... *Bears*
            - Urſus ...... *Bears.*
            - Taxus ...... *Badgers.*
            - Naſua ...... *Coatis.*
            - Procyon ...... *Racoons.*
            - Potos ...... *Kinkajous.*
            - Ichneumon ...... *Mangouſtes.*
        - C. CARNIVORA. No ſeparate thumbs or great toes; the feet reſting on the toes only
          - Muſtela ...... *Weazels*
            - Muſtela ...... *Weazels and Martins.*
            - Lutra ...... *Otters.*
            - Mephitis ...... *Mouffetes.*
          - Viverra ...... *Civets.*
          - Felis ...... *Cats.*
          - Canis ...... *Dogs*
            - Canis ...... *Dogs.*
            - Hyæna ......
        - D. PEDIMANA. Separate great toes on the poſterior feet
          - Didelphis ...... *Opoſſums*
            - Didelphis ...... *Sarigues.*
            - Daſyurus ......
            - Phalangiſta ...... *Phalangers.*
    - Wanting, at leaſt, one kind of teeth
      - F. IV. RODENTIA. Want the canine teeth only
        - Kangurus ...... *Kanguroos.*
        - Hyſtrix ...... *Porcupines.*
        - Lepus ...... *Hares*
          - Lepus ...... *Hares.*
          - Lagomys ...... *Pica.*
        - Cavia ...... *Cavys*
          - Hydrochærus ......
          - Cavia ...... *Agoutis*
        - Caſtor ...... *Beavers.*
        - Sciurus ...... *Squirrels*
          - Pteromys ...... *Polatouches, or Flying Squirrels.*
          - Sciurus ...... *Squirrels.*
        - Cheiromys ...... *Aye-Aye, or Madagaſcar Squirrel.*
        - Mus ...... *Rats*
          - Arctomys ...... *Marmots.*
          - Lemmus ...... *Campagnols, or Field-mice.*
          - Fiber ...... *Ondatra.*
          - Mus ...... *Rats.*
          - Cricetus ...... *Hamſters.*
          - Spalax ...... *Mole-Rats.*
          - Dipus ...... *Jerboas.*
          - Myoxus ...... *Dormice.*
      - F. V. EDENTATA. Want the inciſive and canine teeth
        - Myrmecophaga ...... *Ant-eaters*
          - Myrmecophaga ...... *Ant-eaters.*
          - Echidna ...... *Porcupine Ant-eaters.*
          - Manis ...... *Pangolins or Scaly Lizards.*
        - Orycteropus ...... *Cape Ant-eater.*
        - Daſypus ...... *Armadillos.*
      - F. VI. TARDIGRADA. Want only the inciſive teeth
        - Bradypus ...... *Sloths*
          - Megatherium ...... *Megather.*
  - With Hoofs
    - F. VII. PACHYDERMATA. More than two toes: more than two hoofs
      - Elephas ...... *Elephants.*
      - Tapir ...... *Tapirs.*
      - Sus ...... *Hogs.*
      - Hippopotamus ...... *River Horſe.*
      - Hyrax ...... *Daman.*
      - Rhinoceros ......
    - F. VIII. RUMINANTIA. Two toes: two hoofs
      - Camelus ...... *Camels*
        - Camelus ...... *Camels.*
        - Lama ...... *Peruvian Camels.*
      - Moſchus ...... *Chevrotins, or Muſks.*
      - Cervus ...... *Deer.*
      - Camelo-Pardalis ...... *Giraffe.*
      - Antilope ......
      - Capra ...... *Goats.*
      - Ovis ...... *Sheep.*
      - Bos ...... *Oxen.*
    - F. X. SOLIPEDA. One toe: one hoof
      - Equus ...... *Horſe.*
  - With fin-like Feet
    - F. X. AMPHIBIA. Four feet
      - Phoca ...... *Seals.*
      - Trichechus ...... *Morſes.*
    - F. CETACEA
      - Manatus ...... *Lamantins.*
      - Delphinus ...... *Dolphins.*
      - Phyſeter ...... *Cachalots.*
      - Balæna ...... *Whales.*
      - Monodon ...... *Narwhal.*

TABLE II.

CLASSIFICATION OF BIRDS.

AVES.

- Feet ſhort: toes furniſhed with ſtrong claws: bill hooked ·· ACCIPITRES ·· *(Accipitrine or Rapacious Birds)*
  - Head and part of the Neck without feathers .. NUDICOLLES
    - Vultur ..... *Vultures.*
  - Head covered with feathers; cere at the baſe of the bill ... PLUMICOLLES
    - Falco ...... *Falcons*
      - Gypaetos .... *Griffons.*
      - Aquila ..... *Eagles.*
      - Niſus ...... *Sparrow-hawks.*
      - Buteo ...... *Buzzards.*
      - Milvus ..... *Kites.*
      - Falco ...... *Falcons.*
  - Head flattened from the front backward; eyes directed forward ... NYCTERIDES
    - Strix .... *Owls*
      - Otus .... *Hibous or Horned Owls.*
      - Strix .... *Common Owls.*
- Four toes: three before, one behind: external toes wholly or partially united ·· PASSERES ···· *(Paſſerine or Small Birds)*
  - Bill with the mandible grooved towards the end ... CRENIROSTRES
    - Lanius ..... *Shrikes*
    - Muſcicapa.... *Flycatchers*
      - Tyrannus .... *Tyrant Flycatchers.*
      - Muſcivora.... *Moucherolles.*
      - Muſcicapa.... *Common Flycatchers.*
    - Turdus ..... *Thruſhes.*
    - Ampelis .... *Cotingas or Chatterers.*
    - Tanagra .... *Tanagers.*
  - Bill with notched edges ... DENTIROSTRES
    - Phytotoma ... *Plant-clippers.*
    - Momotus .... *Motmot.*
    - Buceros ..... *Hornbills.*
  - Bill ſtraight, ſtrong, compreſſed, and without a groove ... PLENIROSTRES
    - Gracula ..... *Grakles.*
    - Corvus ..... *Crows.*
    - Coracias .... *Rollers.*
    - Paradiſea .... *Birds of Paradiſe.*
  - Bill conical ... CONIROSTRES
    - Oriolus ..... *Caſciques or Orioles*
      - Cacicus ..... *Caciques.*
      - Icterus ..... *Troop Orioles.*
      - Xanthornus .. *Carouges or Bonana Birds.*
    - Sturnus ..... *Stares.*
    - Loxia ...... *Groſsbeaks*
      - Loxia ...... *Groſsbeak.*
      - Cruci-roſtra .. *Croſsbills.*
      - Chloris ..... *Greenfinches.*
      - Pyrrhula .... *Bullfinches.*
      - Colius ...... *Colys.*
    - Fringilla .... *Sparrows*
      - Fringilla .... *Sparrows.*
      - Cælebs ..... *Chaffinches.*
      - Carduelis .... *Goldfinches.*
      - Vidua ..... *Widow Birds.*
    - Emberiza .... *Buntings.*
  - Bill ſlender, like a puncheon or awl ... SUBULIROSTRES
    - Parus ...... *Titmice.*
    - Pipra .... *Manakins.*
    - Alauda ..... *Larks.*
    - Motacilla .... *Wagtails*
      - Silvia ...... *Warblers.*
      - Erithacus .... *Redbreaſts.*
      - Ficedula .... *Fig-eaters.*
      - Regulus .... *Wrens.*
      - Motacilla .... *Wagtails.*
  - Bill ſhort, flattened horizontally; opening very wide ... PLANIROSTRES
    - Hirundo .... *Swallows*
      - Hirundo .... *Swallows.*
      - Apus ...... *Martins.*
    - Caprimulgus .. *Goat-ſuckers.*
  - Bill ſlender, elongated and ſolid ... TENUIROSTRES
    - Sitta .... *Nuthatches.*
    - Certhia ..... *Creepers.*
    - Trochylus .... *Humming Birds*
      - Trochylus .... *Humming Bird.*
      - Orthorincus .. *Straight-billed Humming Bird.*
    - Upupa ..... *Hoopoes.*
    - Merops ..... *Bee-eaters.*
    - Alcedo ..... *King Fiſhers.*
    - Todus ..... *Todys.*
- Two toes before, and two behind ······· SCANSORES ·· *(Climbers)*
  - Bill ſlender ... CUNEIROSTRES
    - Galbula ..... *Jacamars.*
    - Picus ...... *Woodpeckers.*
    - Yunx ...... *Wrynecks.*
    - Cuculus ..... *Cuckoos.*
  - Bill thick and light ... LEVIROSTRES
    - Crotophaga .. *Anis.*
    - Turacus .... *Touraco.*
    - Muſophaga ...
    - Trogon .... *Curucuis.*
    - Bucco ...... *Barbets.*
    - Ramphaſtos .. *Toucans.*
    - Pſittacus .... *Parrots*
      - Kakatoe .... *Cockatoos.*
      - Pſittacus .... *Parrots.*
      - Ara .... *Maccaws.*
      - Pſittacula .... *Parrakets.*
- The front toes united at their baſe by a ſhort membrane ··· GALLINÆ ··· *(Gallinaceous Birds or Poultry)*
  - Common wings fitted for flying ... ALECTRIDES
    - Columba .... *Pigeons.*
    - Tetrao ..... *Grous*
      - Tetrao ..... *Grous.*
      - Perdrix ..... *Partridges.*
      - Coturnix .... *Quails.*
    - Pavo ...... *Peacocks.*
    - Phaſianus .... *Pheaſants*
      - Phaſianus .... *Pheaſants.*
      - Gallus ..... *Cocks.*
    - Numida .... *Pintados.*
    - Meleagris .... *Turkeys.*
    - Crax .... *Curaſſow.*
    - Penelope .... *Guans.*
    - Otus .... *Buſtards.*
  - Wings too ſhort for flight ... BREVIPENNES
    - Struthio .... *Oſtrich.*
    - Touyou .... *American Oſtrich.*
    - Rhea .... *Caſſowary.*
    - Didus ..... *Dodos.*
- Elevated and naked tarſi: the two external toes united ··· GRALLÆ ···· *(Waders)*
  - Bill ſhort and thick ... BREVIROSTRES
    - Pſophia ..... *Trumpeters.*
    - Palamedea .... *Screamers.*
    - Serpentarius .. *Meſſenger of the Cape, Secretary or Sagittary.*
    - Cancroma .... *Boat-bills.*
    - Phenicopterus *Flamingos.*
  - Bill long, ſtrong, and like a knife ... CULTRIROSTRES
    - Ardea ...... *Herons*
      - Hians ...... *Open-bills.*
      - Ardea ...... *Herons.*
      - Ciconia ..... *Storks.*
      - Grus .... *Cranes.*
      - Scopus ..... *Umbres.*
    - Mycteria .... *Jabiru.*
    - Tantalus .... *Ibises.*
  - Bill long, weak, and flattened horizontally ... LATIROSTRES
    - Platalea .... *Spoonbills.*
  - Bill ſlender, long, and weak ... LONGIROSTRES
    - Recurviroſtra . *Avoſets.*
    - Charadrius ... *Plovers.*
    - Tringa ..... *Lapwings*
      - Tringa ..... *Lapwings.*
      - Totanus .... *Gambets.*
      - Calidris .... *Sandpipers.*
    - Phalaropus ... *Phalaropes.*
    - Scolopax .... *Woodcocks*
      - Scolopax .... *Woodcocks.*
      - Numenius .... *Curlews.*
  - Bill middle-ſized and compreſſed ... PRESSIROSTRES
    - Haematopus .. *Oyſter-catchers.*
    - Rallus ..... *Rails.*
    - Fulica ..... *Coots*
      - Fulica ..... *Coots.*
      - Gallinula .... *Water-hens.*
    - Parra ...... *Jacanas.*
- Toes united by broad membranes ······· ANSERES ··· *(Anſerine or web-footed Water Birds)*
  - The four toes united ... PINNIPEDES
    - Pelecanus .... *Pelicans*
      - Pelecanus .... *Pelicans.*
      - Phalacrocorax . *Cormorants.*
      - Fregata ..... *Frigates.*
      - Sula ...... *Boobys.*
    - Phæton ..... *Tropic-birds.*
    - Plotus ..... *Darters.*
  - Thumb free; bill not indented; wings very long ... MACROPTERES
    - Sterna ..... *Terns.*
    - Larus ..... *Gulls.*
    - Rhynchops ... *Skimmers.*
    - Procellaria ... *Petrels.*
    - Diomedea .... *Albatroſſes.*
  - Thumb free; bill broad and ſerrated; wing of a moderate ſize ... SERRIROSTRES
    - Anas ...... *Ducks.*
    - Mergus ..... *Merganſers.*
  - Thumb either free or wanting; bill not ſerrated; wings very ſhort ... BRACHYPTERES
    - Colymbus .... *Grebes*
      - Colymbus .... *Grebes.*
      - Urinator .... *Divers.*
    - Alca .... *Auks*
      - Uria .... *Guillemots.*
      - Alca .... *Puffins.*
      - Pinguin .... *Penguins.*
    - Aptenodyta .. *Manchots.*

TABLE III.

CLASSIFICATION OF REPTILES.

- AMPHIBIA
  - Two Auricles to the heart
    - A back ſhell; the jaws inveſted with horn …… CHELONIA …… Teſtudo …… *Tortoiſes*
      - Teſtudo …… *Turtles.*
      - Chelonia …… *Tortoiſes.*
    - The body covered with ſcales; teeth …… SAURIA …… Lacerta …… *Lizards*
      - Crocodilus …… *Crocodiles.*
      - Iguana …… *Guanas.*
      - Draco …… *Dragons.*
      - Stellio …… *Stellions.*
      - Gecko ……
      - Lacerta …… *Lizards.*
      - Scincus …… *Scinks.*
      - Chalcis
      - Seps
  - One Auricle to the heart
    - Body covered with ſcales; no feet; never branchiæ …… OPHIDIA
      - Anguis.
      - Amphiſbæna.
      - Cæcilia.
      - Acrocordon.
      - Angaha.
      - Coluber …… *Snakes*
        - Vipera …… *Vipers.*
        - Aſpis …… *Aſps.*
        - Coluber …… *Common Snakes.*
      - Boa.
      - Crotalus …… *Rattle Snakes*
    - Skin naked; feet; branchiæ in the young …… BATRACHIA
      - Rana …… *Frogs*
        - Rana …… *Frogs.*
        - Hyla …… *Tree Frogs.*
        - Bufo …… *Toads.*
      - Salamandra …… *Salamanders*
        - Salamandra …… *Salamanders.*
        - Triton
      - Siren.

TABLE IV.

CLASSIFICATION OF FISHES.

- PISCES.
  - With a cartilaginous skeleton
    - Fixed branchiæ …… CHONDROPTERYGII
      - Round mouth at the end of the noſe or ſnout
        - Petromyzon …… *Lampreys.*
        - Myxine …… *Hags.*
      - Tranſverſe mouth under the ſnout
        - Raia …… *Rays.*
        - Squalus …… *Dog-fiſh.*
        - Chimæra …… *Sea Monsters.*
    - Free branchiæ …… BRANCHIOSTEGI
      - Tranſverſe mouth under the ſnout; teeth
        - Batrachus …… *American Toad-fiſh.*
        - Polyodon.
      - Tranſverſe mouth under the ſnout; no teeth
        - Acipenſer …… *Sturgeons.*
        - Pegaſus.
      - Mouth at the end of the noſe; no teeth
        - Syngnathus …… *Pipe-fiſh.*
        - Centriſcus …… *Bellows-fiſh.*
      - Mouth at the end of the noſe; teeth
        - Baliſtes …… *Horned-fiſh.*
        - Oſtracion …… *Trunk-fiſh.*
      - The bones of the jaws anſwering inſtead of teeth
        - Tetraodon …… *Sun-fiſh.*
        - Ovoides.
        - Mola …… *Moles.*
        - Diodon …… *Porcupine-fiſh.*
      - Mouth very wide; a number of ſmall teeth
        - Lophius …… *Frog-fiſh.*
        - Cyclopterus …… *Lump-fiſh.*
  - With an Oſſeous Skeleton
    - No ventral fins …… APODES
      - Mouth at the end of the noſe
        - Muraena …… *Eels.*
        - Gymnothorax.
        - Synbranchus.
        - Sphagebranchus …… *Cecilia.*
        - Gymnotus …… *Electric Eels.*
        - Trichiurus.
        - Gymneterus …… *King of the Herrings.*
        - Ophidium ……
        - Ammodytes …… *Sand-eels or Launces.*
        - Anarrhichas …… *Sea Wolves.*
      - Mouth under the noſe or muzzle …… Xiphas …… *Sword-fiſh.*
    - The ventral fins ſituated before the pectoral …… JUGULARES
      - Head unarmed
        - Gadus …… *Haddocks.*
        - Blennius …… *Blennys.*
        - Kurtus …… *Hunch-back.*
      - Head armed
        - Callionymus …… *Dragonets.*
        - Trachinus …… *Weavers or Sea-Dragon*
        - Uranoſcopus …… *Stargazers.*
    - The ventral fins ſituated under the pectoral …… THORACICI
      - Dorſal fins partly ſpinous; head armed
        - Cottus …… *Bull-heads.*
        - Scorpæna …… *Scorpions.*
        - Trigla …… *Gurnards.*
      - Dorſal fins partly ſpinous; head unarmed
        - Two dorſal fins
          - Gobius …… *Gobys.*
          - Mullus …… *Surmullet.*
          - Scomber …… *Mackrels.*
          - Gaſteroſteus …… *Sticklebacks.*
          - Macrourus …… *Longtails.*
          - Lonchiurus ……
          - Johnius …… *Johnes.*
          - Sciæna …… *Sciænes.*
        - One dorſal fin
          - Zeus …… *Dorees.*
          - Stromateus ……
          - Theuthis ……
          - Chætodon ……
          - Coryphæna …… *Dorados.*
          - Bodianus …… *Bodians.*
          - Holocentrus ……
          - Lutianus …… *Lutians.*
          - Perca …… *Perches.*
          - Anthias ……
          - Epinelephus ……
          - Labrus …… *Wraſſes.*
          - Sparus …… *Breams.*
      - Bones of the jaws naked, and anſwering inſtead of teeth …… Scarus …… *Scares.*
      - Two eyes on the ſame ſide …… Pleuronectes …… *Flounders.*
      - The body very long
        - Cæpola …… *Sea Serpents.*
        - Lepidopus.
      - A furrowed diſcus on the head …… Echeneis …… *Remoras.*
    - The ventral fins ſituated behind the pectoral …… ABDOMINALES
      - No operculum to the branchiæ …… Mormyrus ……
      - No teeth
        - Cyprinus …… *Carps.*
        - Mugil …… *Mullets.*
        - Exocœtus …… *Flying-fiſh.*
      - Sharp teeth; no cirri
        - Polynemus ……
        - Clupea …… *Herrings.*
        - Atherina …… *Atherines.*
        - Argentina …… *Argentines.*
        - Salmo …… *Salmons.*
        - Eſox …… *Pikes.*
      - Head depreſſed; cirri
        - Cobitis …… *Loches.*
        - Anableps.
        - Silurus.
        - Platyſomatus.
        - Cataphractus …… *Armed-fiſh.*
        - Loricaria …… *Cuiraſs-fiſh.*
        - Amia ……
      - Spines free on the back …… Acanthonotus ……
      - Mouth at the end of a long noſe …… Fiſtularia …… *Tobacco-pipe-fiſh.*

TABLE V.

CLASSIFICATION OF MOLLUSCA.

- MOLLUSCA.
  - Head covered with tentacula, which serve for feet · · FAM. I. CEPHALOPODA
    - Naked — Sepia — *Cuttle-fiſh.*
      - Sepia — *Cuttle-fiſh.*
      - Loligo — *Calmars.*
      - Octopus — *Pulps.*
    - Testaceous
      - Argonauta — *Paper Nautilus.*
      - Nautilus — *Pearl Nautilus.*
  - Head free, and crawl upon the belly — II. GASTEROPODA
    - No ſhell; or the ſhell concealed by the fleſh
      - Clio
      - Scylæa
      - Doris
        - Doris — *Sea Lemon.*
        - Tritonia.
        - Eolia.
      - Phyllidia.
      - Thetis.
      - Limax — *Slugs.*
      - Teſtacella.
      - Sigaretus.
      - Aplyſia — *Stinking Sea Snails.*
    - The ſhell apparent
      - In ſeveral pieces — MULTIVALVES — Chiton.
      - Conical — CONIVALVES — Patella — *Limpets*
        - Fiſſurella.
        - Patella — *Limpets.*
        - Crepidula.
        - Calyptræa.
      - Spiral — SPIRIVALVES
        - Aperture entire
          - Halyotis — *Sea ears.*
          - Nerita — *Sea Snails*
            - Nerita.
            - Natica.
          - Turbo — *Perriwinkles*
            - Turbo — *Perriwinkles.*
            - Cycloſtoma.
            - Turritella — *Staircaſe Shells.*
          - Vermetus.
          - Trochus — *Top-ſhells*
            - Pyramidella.
            - Trochus — *Tops.*
            - Monodonta.
            - Solarium.
          - Bulla — *Dipper-ſnails.*
          - Helix — *Snail-ſhells*
            - Planorbis.
            - Helix — *Snails.*
            - Ampullaria.
            - Melania.
            - Bulimus.
            - Achatina.
        - Aperture ſloped towards the bottom
          - Voluta — *Volutes*
            - Voluta.
            - Mitra — *Mitral Volutes.*
            - Columbella.
            - Marginella.
            - Ancilla.
            - Oliva — *Olive-ſhells.*
          - Ovula
          - Cypræa — *Gowrys or Porcelain Shells.*
          - Conus — *Cones.*
          - Terebellum.
        - Aperture ending in a canal
          - Murex
            - Cerithium.
            - Pleurotoma.
            - Fuſus.
            - Faſciolaria.
            - Pyrula.
            - Murex.
            - Turbinella.
          - Strombus
            - Strombus.
            - Pterocera.
            - Roſtellaria.
          - Buccinum — *Whelks*
            - Caſſidea — *Helmet-ſhells.*
            - Harpa.
            - Buccinum — *Whelks.*
            - Terebra.
            - Purpura — *Purple-fiſh:*
            - Naſſa.
  - No diſtinct head — III. ACEPHALA
    - With a membranous or coriaceous cloak; no ſhells
      - Aſcidia.
      - Salpa.
      - Pterotrachea.
      - Thalia.
    - With a cloak, furniſhed with ſhells
      - Open anteriorly; no articulated tentacula, nor ciliated arms
        - INEQUIVALVES
          - Oſtrea — *Oyſters*
            - Oſtrea — *Oyſters.*
            - Pedum.
          - Lazarus.
          - Spondylus — *Thorny Oyſter.*
          - Placuna.
          - Anomia.
          - Pecten — *Scallops.*
        - EQUIVALVES; a foot adapted for crawling; no tubes
          - Anodontites.
          - Unio.
        - EQUIVALVES; a foot conſtructed for ſpinning; no tubes
          - Lima.
          - Perna.
          - Avicula
            - Avicula — *Swallow-tail Shells.*
            - Malleus — *Hammer-ſhells.*
          - Mytilus — *Muſcles*
            - Mytilus.
            - Modiolus.
          - Pinna.
        - Tubes in the cloak for the anus and reſpiration; the foot frequently fitted for ſpinning
          - Tellina.
          - Cardium — *Cockles*
            - Cardium — *Cockles.*
            - Iſocardia.
          - Mactra
            - Mactra.
            - Lutraria.
            - Craſſatella.
          - Venus
            - Venus.
            - Meretrix.
            - Cyclas.
            - Paphia.
            - Capſa.
          - Donax.
          - Chama
            - Cardita.
            - Tridacna.
            - Hippopus.
          - Arca
            - Arca.
            - Petunculus.
            - Nucula.
      - Open at one end, through which the foot paſſes; prolonged towards the other in a double tube
        - Solen — *Razor-ſhells*
          - Solen — *Razor ſhells.*
          - Sanguinolaria.
        - Mya — *Gapers*
          - Mya — *Gapers.*
          - Glycimeris.
          - Cyrtodaria.
        - Pholas — *Piddocks*
          - Pholas — *Piddocks.*
          - Gicenia.
        - Teredo — *Pipe-worms*
          - Teredo — *Pipe-worms.*
          - Fiſtulana.
      - Open before; neither foot nor tubes; two ciliated arms, rolled into a ſpiral form
        - Terebratula
          - Terebratula.
          - Calceola.
          - Hyalæa.
        - Lingula.
        - Orbicula.
      - Open before; neither feet nor tubes; one tube proceeding from the body; horny articulated tentacula; ranged in pairs
        - Anatifa — *Barnacle-ſhells.*
        - Balanus.

TABLE VI.

CLASSIFICATION OF WORMS.

VERMES	External organs for respiration	Setæ upon the ſides of the body	Aphrodita	*Aphrodites.*
			Terebella.	
			Nereis.	
			Serpula.	
			Penicillus.	
			Siliquaria.	
			Amphitrite.	
			Dentalium	*Tooth ſhells.*
	No external organs for respiration	Setæ upon the ſides of the body	Naïs.	
			Lumbricus	*Common Worms.*
			Thalaſſema.	
		Without ſetæ upon the ſides of the body	Hirudo	*Leeches.*
			Faſciola	*Flukes.*
			Planaria.	
			Gordius	*Animated Hairs.*

Animals ſimilar to Worms, the organization of which is not yet ſufficiently known to determine whether they ſhould be included in the above claſs, or form one next to the Zoophytes	Firſt Family	Tœnia	*Tape-worms.*
		Hydatigena	*Hydatids.*
		Ligula.	
		Linguatula.	
	Second Family	Aſcaris	*Aſcarides.*
		And all the other inteſtinal worms.	

TABLE VII.

CLASSIFICATION OF THE CRUSTACEA.

CRUSTACEA	MONOCULUS	Limulus.	
		Calygus.	
		Apus.	
		Cyclops.	
		Polyphemus.	
	CANCER	Cancer	*Crabs.*
		Inachus	*Sea Spiders.*
		Pagurus	*Hermits.*
		Aſtacus	*Cray-fiſh.*
		Palinurus	*Some Lobſters.*
		Scyllarus.	
		Squilla	*Shrimps.*

TABLE VIII.

CLASSIFICATION OF INSECTS.

- INSECTA.
  - With Jaws
    - No Wings …… GNATHAPTERA
      - Several pair of jaws …… POLYGNATHA
        - Phyſodes -
        - Oniſcus - *Wood-lice.*
        - Cymothoa - *Sea-lice.*
      - Two jaws; feet to each annular ſegment of the body …… MILLEPEDA
        - Julus - *Millepedes.*
        - Scolopendra - *Centipedes.*
      - Head united to the corcelet; eight feet; abdomen without feet …… ARANEIDA
        - Scorpio - *Scorpions.*
        - Phalangium - *Shepherds-weavers.*
        - Aranea - *Spiders.*
        - Hydrachna - *Water-spiders.*
      - Head diſtinct; ſix feet; abdomen terminated by ſetæ …… SETICAUDA
        - Podura - *Springtails.*
        - Lepiſma -
      - Head diſtinct; ſix feet; abdomen without hairs …… Ricinus - *Lice of many birds.*
    - Four Reticulated Wings …… NEUROPTERA
      - Lip covering the mouth; wings extended in repoſe …… ODONATA
        - Libellula - *Dragon-flies.*
        - Aeſhna -
        - Agrion -
      - Mouth projecting; wings lying on the body when the inſect reſts …… TECTIPENNATA
        - Termes - *Ticking Inſects.*
        - Hemerobius - *Golden-eyes.*
        - Semblis -
        - Myrmeleon - *Lion-ants.*
        - Aſcalaphus -
        - Panorpa - *Scorpion Flies.*
        - Raphidia -
      - Mouth very ſmall; no mandibles …… AGNATHA
        - Phryganea - *Cadow Flies.*
        - Ephemera - *Day Flies.*
    - Four venous Wings …… HYMENOPTERA
      - With a pedunculated abdomen
        - Lip prolonged, forming a proboſcis …… MELLITA
          - Apis - *Bees.*
          - Eucera -
          - Nomada -
          - Andræna -
          - Hylæus -
        - Superior wings folded throughout their whole length; Antennæ enlarged at the extremity …… DUPLIPENNATA
          - Veſpa - *Common Waſps.*
          - Maſaris -
        - Antennæ as if broken; abdomen concave inferiorly …… Chryſis - *Golden Flies, or Gilded Waſps.*
        - Antennæ filiform; wings not folded; abdomen round; lip ſhort …… ANTHOPHILIA
          - Philanthus -
          - Scolia -
          - Crabro -
          - Mellinus -
          - Bembex -
        - Antennæ ſetaceous, twelve or thirteen joints, rolling into a ſpire …… FOSSATORA
          - Larra -
          - Sphex - *Savages, or Solitary Waſps.*
          - Tiphia -
        - Antennæ ſetaceous, and as if broken; abdomen round; a ſting …… MYRMECEA
          - Dorylus -
          - Formica - *Ants.*
          - Mutilla -
        - Antennæ as if broken, with thirty articulations; terebra projecting …… INSECTIRODA
          - Evania -
          - Ichneumon - *Ichneumons.*
        - Antennæ either filiform or clavate; terebra ſpiral …… Cynips - *Gall Flies.*
      - With a ſeſſile abdomen
        - Palpi ſcarce perceptible; terebra very projecting …… Urocerus - *Tailed Waſps.*
        - Palpi very apparent; terebra ſerrated …… Tenthredo - *Saw Flies.*
    - Four wings; the ſuperior hard, the inferior folded tranſverſely …… COLEOPTERA
      - With ſix palpi …… Antennæ filiform or ſetaceous …… CARNIVORA
        - Dytiſcus - *Water Beetles.*
        - Gyrinus - *Water Fleas.*
        - Carabus - *Ground Beetles.*
        - Scarites -
        - Cicindela - *Sparklers.*
        - Elaphrus -
      - With four palpi
        - Tarſi 5, 5, 5.
          - Antennæ club-ſhaped; the end lamellated …… LAMELLICORNEA
            - *Lucani.*
              - Lucanus - *Stag Beetles.*
              - Platycerus - *Elk Beetles.*
              - Paſſalus -
              - Synodendron -
            - *Scarabæi.*
              - Geotrupes -
              - Copris - *Dung Beetles.*
              - Aphodius -
              - Scarabæus - *Bull-combers.*
              - Melolontha - *May Beetles.*
              - Cetonia -
              - Trichius - *Hairy Beetles.*
              - Trox -
          - Antennæ club-ſhaped and perfoliate or ſolid …… CLAVICORNEA
            - Nicrophorus - *Interrers, or Corpſe Carriers.*
            - Silpha - *Protectors.*
            - Nitidula -
            - Elophorus -
            - Hydrophilus - *Divers.*
            - Sphæridium -
            - Scaphidium -
            - Hiſter -
            - Lethrus -
            - Byrrhus -
            - Anthrenus -
            - Dermeſtes - *Flea Beetles.*
          - Antennæ moniliform; elytra ſhort …… BRACHELYTRA
            - Staphylinus - *Rove Beetles.*
            - Pæderus -
            - Oxyporus -
            - Stenus -
          - Antennæ filiform
            - With hard elytra …… LIGNATORA
              - Anobium - *Piercers.*
              - Ptilinus -
              - Ptinus - *Death Watches.*
              - Elater - *Skippers.*
              - Melaſis -
              - Bupreſtis - *Cow-burners.*
            - With ſoft elytra …… APALYTRA
              - Lampyris - *Glow Worms.*
              - Lycus -
              - Telephorus -
              - Malachius -
              - Lymexylon - *Woodfilers.*
              - Tillus -
              - Drillus -
        - Tarſi, 5, 5, 4. …… Antennæ variable
          - With hard elytra …… LUCIFUGA
            - Tenebrio - *Darklings.*
            - Helops -
            - Blaps -
            - Scaurus -
            - Sepidium -
            - Erodius -
            - Pimelia -
            - Eurychora -
            - Opatrum -
            - Serropalpus -
            - Diaperis -
            - Hipophlæus -
            - Mordella - *Niblers.*
          - With ſoft elytra …… VESICATORIA
            - Meloe - *Bloſſom Eaters.*
            - Lytta - *Bliſtering Cantharides.*
            - Mylabris -
            - Cerocoma -
            - Notoxus -
            - Pyrochroa -
            - Lagria -
            - Ciſtela -
            - OEdemera -
        - Tarſi 4, 4, 4.
          - Antennæ fixed on the roſtrum …… ROSTRICORNEA
            - Curculio - *Weevils.*
            - Attelabus -
            - Brentus -
            - Anthribus -
            - Brachycerus -
            - Rhinomacer -
            - Bruchus -
          - Antennæ ſetaceous …… LIGNIVORA
            - Prionus -
            - Lamia -
            - Cerambix - *Goat Chaffers.*
            - Saperda -
            - Callidium -
            - Spondilis -
            - Rhagium -
            - Leptura - *Wood Beetles.*
            - Donacia -
            - Necydalis - *Carrion Eaters.*
          - Antennæ club-ſhaped; body often cylindrical …… TERETIFORMA
            - Boſtrichus -
            - Clerus -
            - Apate -
            - Colydium -
            - Lyctus -
          - Antennæ granular, enlarged at the end; body flat …… PLANIFORMA
            - Trogoſſita -
            - Ips -
            - Mycetophagus -
          - Antennæ filiform or moniliform; body convex …… HERBIVORA
            - Caſſida - *Tortoiſe Beetles.*
            - Chryſomela -
            - Galeruca -
            - Altica - *Earth Fleas.*
            - Cryptocephalus -
            - Crioceris -
            - Luperus -
            - Hiſpa - *Spinous Beetles.*
        - Tarſi, 3, 3, 3. …… Antennæ club-ſhaped …… Coccinella - *Ladybirds.*
    - Four Wings, the ſuperior hard, the inferior folded longitudinally. …… ORTHOPTERA
      - Wings folding longitudinally and tranſverſely; anus terminated by a forceps …… Forficula - *Earwigs.*
      - Body flat; head inflected under the corcelet …… Blatta - *Cockroaches.*
      - Corcelet much elongated ……
        - Mantis - *Soothſayers.*
        - Spectrum - *Spectres.*
      - Poſterior feet fitted for leaping; body cylindrical …… SALTATORIA
        - Locuſta - *Locuſts.*
        - Acheta - *Field, Mole, and Houſe Crickets.*
        - Achrydium - *Some Crickets.*
        - Gryllus - *Graſshoppers.*
        - Truxalis -
  - Without Jaws
    - Four Wings frequently croſſed; roſtrum articulated …… HEMIPTERA
      - Roſtrum ariſing from the anterior part of the head …… FRONTIROSTRA
        - Acanthia - *Houſe Bug, and ſome others.*
        - Cimex - *Bugs.*
        - Coreus -
        - Lygæus -
        - Gerris -
        - Hydrometra -
        - Reduvius -
        - Ranatra - *Froghoppers.*
        - Nepa - *Water Scorpions.*
        - Naucoris -
        - Sigara -
        - Notonecta - *Boat Flies.*
      - Roſtrum appearing to riſe from the neck …… COLLIROSTRA
        - Fulgora - *Fire Flies.*
        - Tettigonia - *Small Graſshoppers.*
        - Cicada -
        - Membracis -
      - Wings not croſſed; extended …… PLANIPENNATA
        - Thrips -
        - Aphis - *Plant Lice.*
        - Aleirodes -
        - Chermes - *Gall Inſects.*
        - Coccus - *Cochineal Inſects.*
    - Four Wings covered with ſcales; proboſcis ſpiral …… LEPIDOPTERA
      - Antennæ terminated by a ſolid maſs …… Papilio - *Butterflies.*
      - Antennæ bent at their extremity …… Heſperia -
      - Antennæ enlarged towards the middle …… FUSICORNEA
        - Sphinx - *Hawk Moths.*
        - Seſia -
        - Zygæna -
      - Antennæ ſetaceous …… SETICORNEA
        - Bombix -
        - Coſſus -
        - Hepialus -
        - Noctua -
        - Phalæna -
        - Pyralis -
        - Tinea -
        - Allucita -
        - Pterophorus -
    - Only two Wings …… DIPTERA
      - Antennæ filiform or penniform; a proboſcis …… HYDROMIA
        - Tipula - *Crane Flies.*
        - Ceratoplatus -
        - Scatopſus -
      - Proboſcis fleſhy, retractile, and terminated by two lips …… SARCOSTOMA
        - Muſca - *Common Flies.*
        - Syrphus -
        - Rhingia -
        - Stratyomis - *Armed Flies.*
        - Ceria -
        - Nemotelus -
        - Anthrax -
        - Bibio -
        - Rhagio -
        - Tabanus - *Great Horſe Flies.*
      - Antennæ very ſhort; ſucker horney and projecting; no proboſcis …… SCLEROSTOMA
        - Empis -
        - Bombilius - *Humble Bees.*
        - Myopa -
        - Conops -
        - Stomoxis -
        - Aſilus - *Hornet Flies.*
        - Culex - *Gnats.*
        - Hippoboſca - *Horſe Flies.*
      - Antennæ ſhort; neither ſucker nor proboſcis …… Oeſtrus - *Gad Flies.*
    - No Wings …… APTERA …… PARASITA
      - Pulex - *Fleas.*
      - Pediculus - *Lice.*
      - Acarus - *Ticks and Mites.*

TABLE IX. AND LAST.

CLASSIFICATION OF THE ZOOPHYTES.

ZOOPHYTA.	Unattached	With a calcareous or coriaceous covering; the inteſtines floating in the internal cavity	ECHINODERMATA	Echinus	*Urchins*	Echinus	*Urchins.*
						Briſſus	*Flower-like Echini.*
						Spatagus	*Sea Eggs.*
				Aſterias	*Star-fiſh.*		
				Holothuria.			
				Sipunculus	*Sipuncules.*		
		With a fleſhy or gelatinous covering; inteſtines wide and adherent within the maſs of the body	URTICA-MARINA	Actinia	*Anemonies*	Actinia	*Anemonies.*
						Zoanthus.	
				Meduſa	*Meduſa, or Sea Nettles*	Meduſa	*Sea Nettles.*
						Beroe.	
						Rhizoſtoma.	
		Very ſmall; ſwimming in liquors	INFUSORIA	Rotifer	*Wheel Animals.*		
				Brachionus.			
				Trichocercus.			
				Trichoda.			
				Leuchophrus.			
				And all the other Animalcula Infuſoria.			
		With a gelatinous body; propagating by ſhoots or branches	POLYPA	Hydra	*Polyps with arms.*		
				Vorticella	*Flower-polyps.*		
	Attached to a ſolid trunk	In which the medullary ſubſtance traverſes a horny axis, and terminates in polyps upon its branches	ZOOPHYTA properly ſo called	Floſcularia.			
				Tubularia	*Tubular Coralline.*		
				Capſularia.			
				Sertularia	*Sea-moſs.*		
		In which each polyp is incloſed in a horny or calcareous cell; without being connected to a medullary axis	ESCARA	Cellularia.			
				Fluſtra	*Mat-weed.*		
				Corallina	*Common Corallines.*		
		In which the ſolid axis is covered with ſenſible fleſh, from the hollows of which proceed polyps	CERATOPHYTA	Antipathes.			
				Gorgonia.			
				Corallium	*Coral.*		
				Isis	*Jointed Coral.*		
				Pennatula	*Feather-like Coralline.*		
				Veretillum			
				Umbellula	*Umbelliferous Coralline.*		
		In which the axis or ſtony baſis has cavities, which ſerve as receptacles for the polyps	LYTHOPHYTA	Madrepora	*Madrepores.*		
				Millepora	*Millepores.*		
		n which the baſis is ſpongy, friable, or fibrous	SPONGIA	Alcyonium.			
				Spongia	*Sponge.*		

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Echinus .... *Urchins.*
.... Briſſus .... *Flower-like Echini.*
t] Spatagus .... *Sea Eggs.*

s.

s .... Actinia .... *Anemonies.*
Zoanthus.

t

Meduſa .... *Sea Nettles.*
r Sea Nettles... Beroe.
Rhizoſtoma.

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